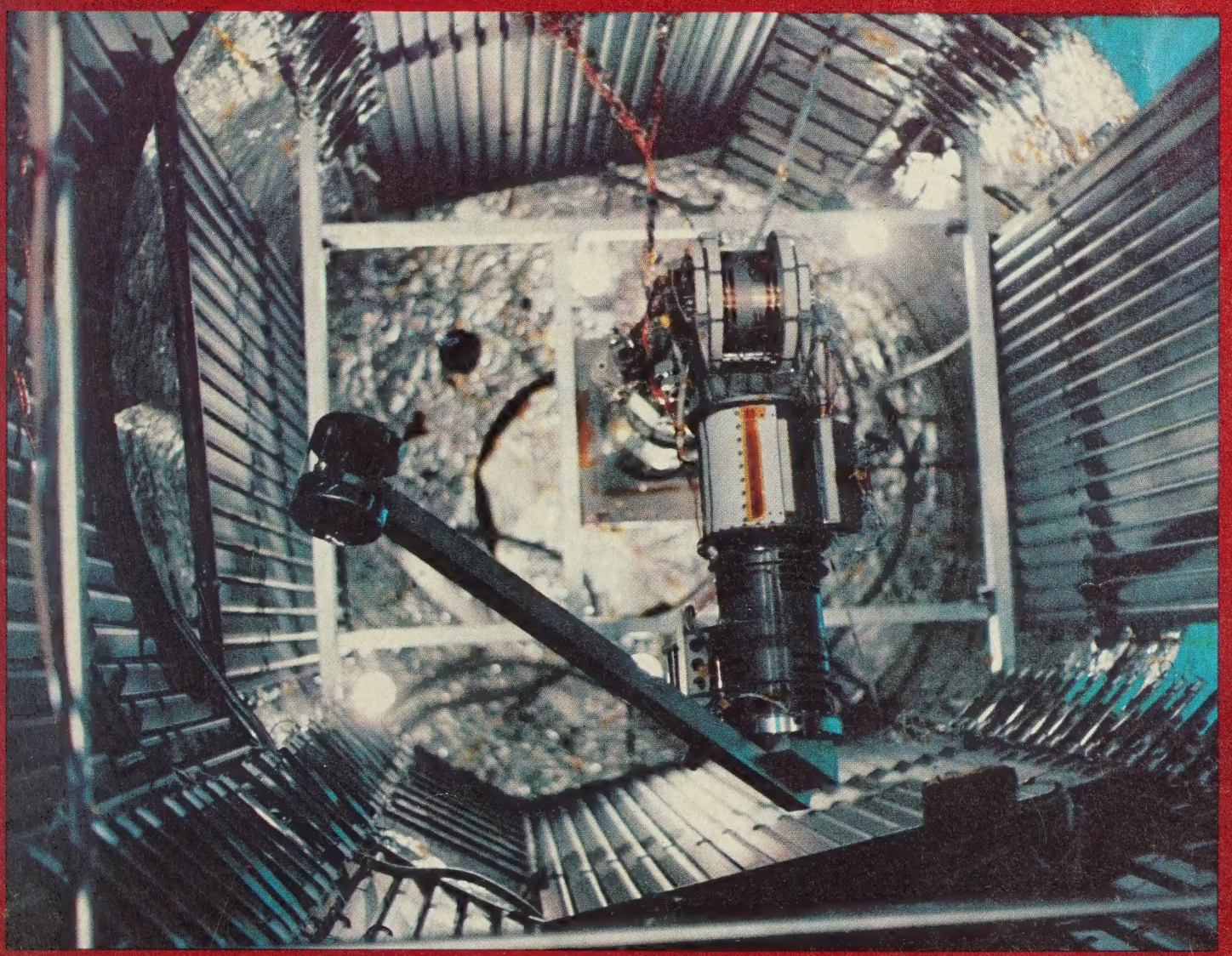


54/31-14

Canadian
Space Products
and
Services

Canadian Space Products and Services

CAI
CØ
-Z009



Cover photo: A portion of the remote manipulator arm (Canadarm) built by Spar Aerospace Limited for the US Space Shuttle receives its space initiation in the 3m x 9m thermal vacuum chamber.

NOTE: The material contained in this publication was assembled under contract by Evert Communications Limited from the companies listed. Although every attempt was made to ensure the accuracy and completeness of the information, neither the Department of Communications nor the contractor assumes any responsibility for the accuracy of the content.

CANADIAN SPACE PRODUCTS AND SERVICES

CA/
CP
- 2009


Rich mineral resources, a sparse population over a vast land mass and oceans on three coasts have all contributed to Canada's interest and pioneering work in space satellites. Canada has successfully designed and built several scientific spacecraft--its Alouette 1, launched in 1962, made Canada the third member of the worldwide space club. Its Communications Technology Satellite (Hermes) was the first communications satellite to operate in 14/12 GHz bands and to use earth stations less than a metre in diameter. Canada was the first nation with a domestic commercial communications satellite system in geostationary orbit.

Canadian experts also participate in a wide range of international space activities. In reaching these achievements and aiming for new ones, the Canadian government and industry have worked closely together. Canadian firms build complete spacecraft, are world leaders in earth station design and construct specialized spacecraft, test equipment as well as satellite data processing systems.

This booklet provides brief details on the members of the industry and a list of established consultants in the field. Each firm would be pleased to provide more detailed information upon request. For more general information about Canada's space programs, contact:

Director, Space Applications and Industry Branch,
Department of Communications,
300 Slater Street,
Ottawa, Ontario, Canada
K1A 0C8

September 1981



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ANDREW ANTENNA COMPANY LIMITED

**606 Beech Street
Whitby, Ontario
LIN 5S2**

Earth Station Antennas, Transmission Lines and Related Equipment

Andrew Antenna Co. Ltd. was granted a Dominion Charter by the Government of Canada in 1953. Its design and manufacturing efforts have been centred on earth station antennas, transmission lines and related equipment.

Main Space Communications Systems, Proprietary Products and Services:

- 4 and 6 GHz earth station antennas
- 12 and 14 GHz earth station antennas
- Mobile earth station antennas
- TV receive only earth station antennas
- Monopulse tracking feed system
- Portable Earth Station for MUSAT (Multiple Usage Satellite)

Other Company Products and Services:

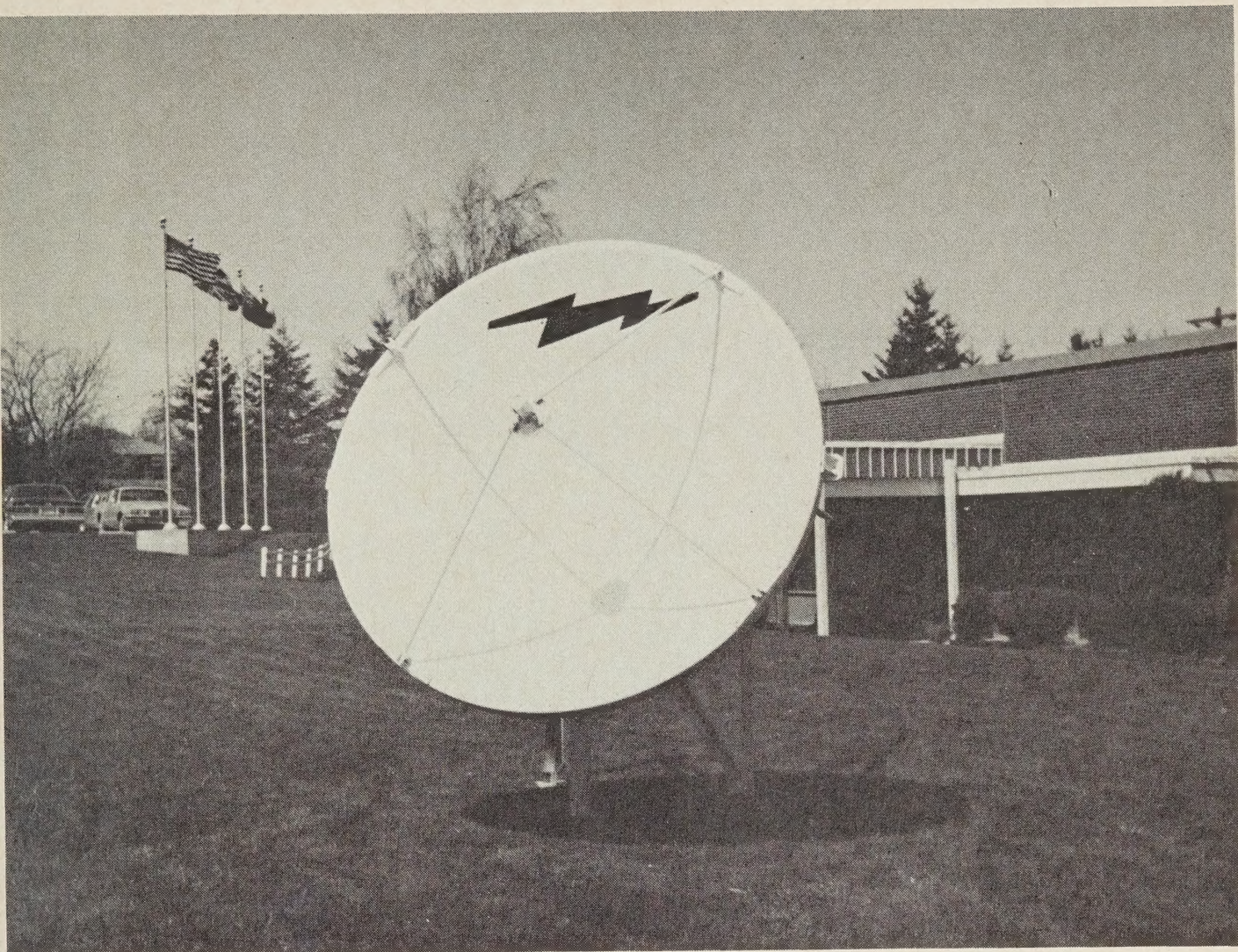
- Interfacility links - waveguide and cables
- Earth station accessories - pressurization, de-icing
- Field installation and acceptance testing
- Solar energy collector
- VOR antennas
- Radar antennas
- Field installation and testing
- Coaxial cables, elliptical waveguides and radiating cables
- Microwave terrestrial antennas

Personnel: 175

Annual sales: \$12 million in 1980

Contact:

**Mr. Alex R. Mackenzie
Sales & Marketing Manager
Telephone: (416) 668-3348
Telex: 069-81269
TWX: 610-384-2754**



Andrew Antenna 2.4 m 4 GHz TV receive only earth station antenna at head office in Whitby, Ontario.



Andrew Antenna 8 m 14/12 GHz earth station antenna.

BARRINGER RESEARCH LIMITED

**304 Carlingview Drive
Rexdale, Ontario
M9W 5G2**

Electro-optical and Electromagnetic Remote Sensing Equipment

System concepts and
prototype development;
geophysical and geochemical
exploration.

Main Space Communications Systems, Proprietary Products and Services:

- Gas filter correlation spectrometer
(GASPEC - space hardened)

Other Company Products and Services:

- Correlation interferometer
- Correlation spectrometer (COSPEC)
- Geomagnetics
- Atmospheric propagation; visible, IR, UV
- Airborne electromagnetics
- Geochemical and analytical chemistry
services
- Pollution monitoring
- Magnetometry
- Heavy water concentration monitor for
CANDU nuclear reactors

Personnel: 90

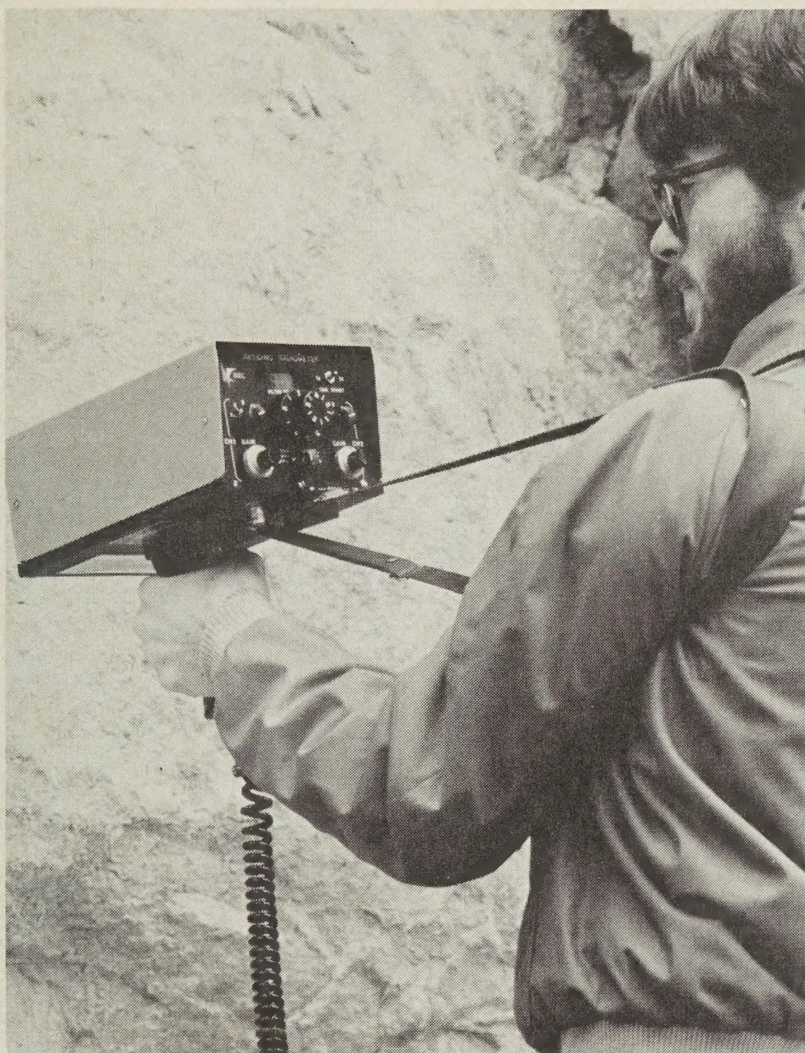
Annual sales: \$4 million in 1980

Contact:

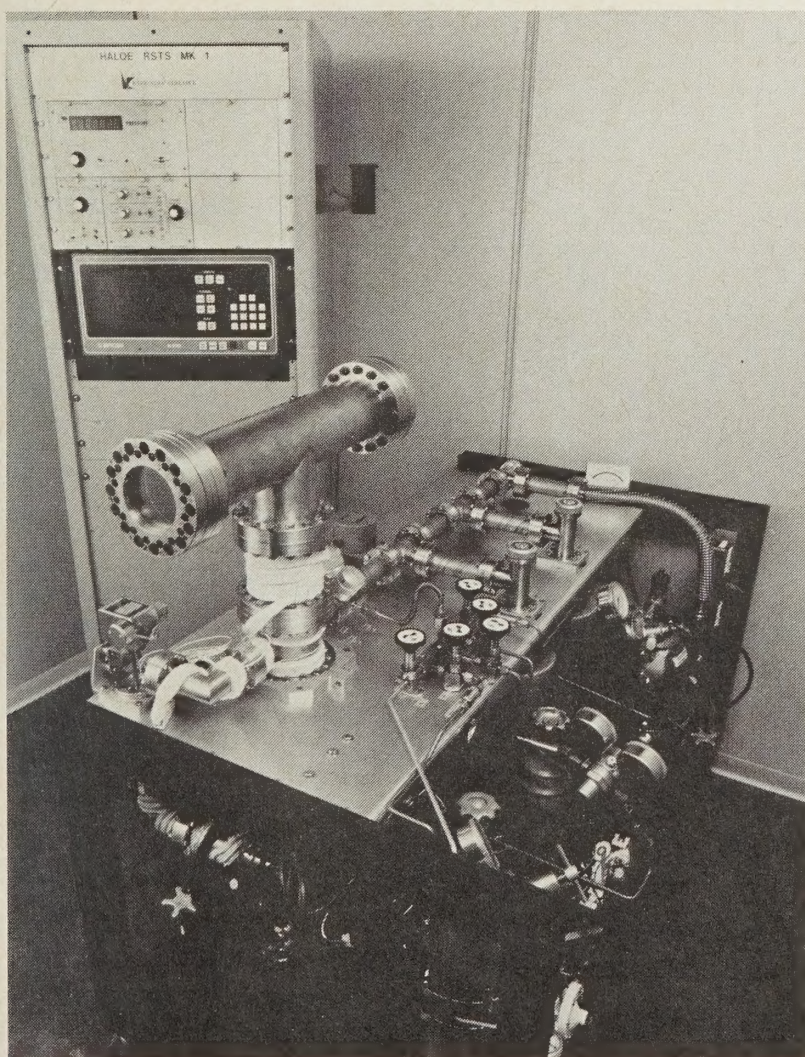
Dr. Cameron Cumming

Telephone: (416) 675-3870

Telex: 06-989183



Barringer hand-held Ratioing Radiometer to conduct ground truthing and improve interpretation of LANDSAT or SPOT imagery.



Barringer ultra high vacuum pumping station and calibration cell ground support equipment for HALOE Project.

BOEING OF CANADA LTD., WINNIPEG DIVISION

**99 Murray Park Road
Winnipeg, Manitoba,
R3J 3M6**

Fibre Re-inforced Composites

The firm was founded in 1969 and has supplied structural and waveguide composites to Canadian and American space programs.

Main Space Communications Systems, Proprietary Products and Services:

- Graphite epoxy
- Waveguide
- Structural composites for satellite systems
- Structural design and analysis

Personnel: 575

Annual sales: \$25 million in 1980

Contact:

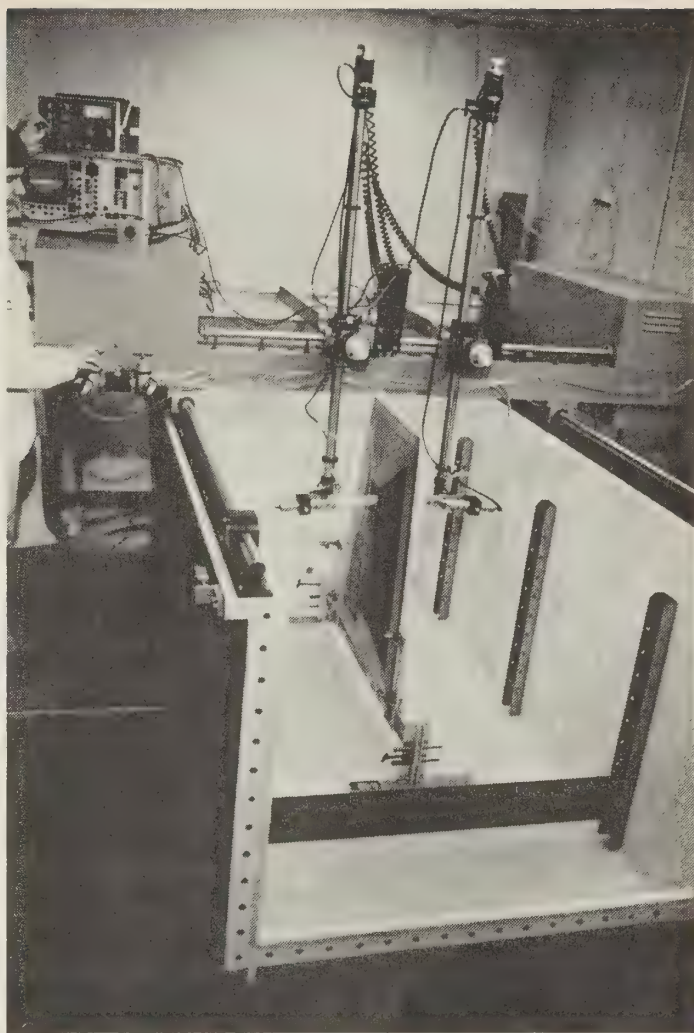
Mr. E.M. Sloane

Telephone: (204) 888-2300

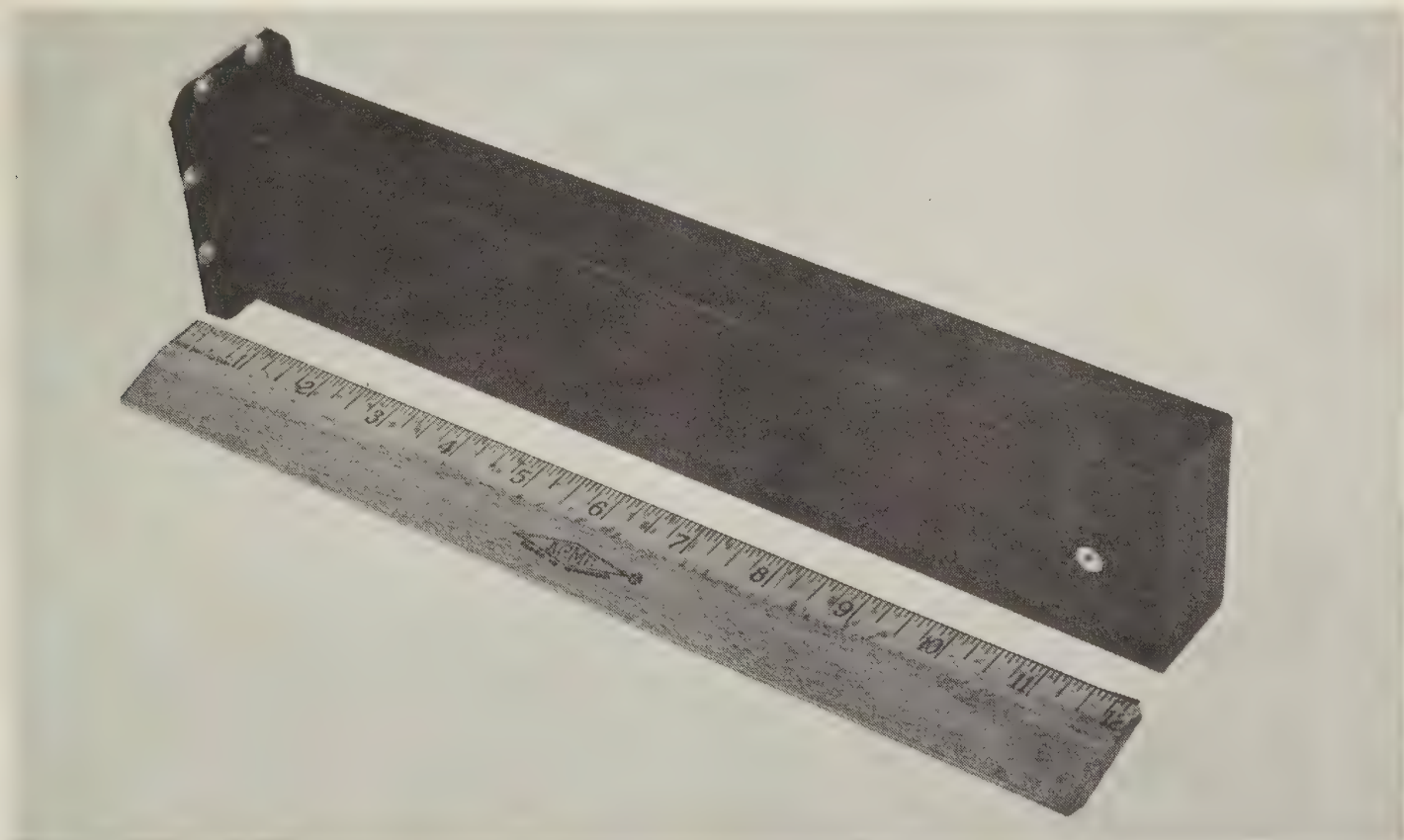
Telex: 07-57309



Lightweight Boeing graphite epoxy and kevlar tower support structure for use on a communications satellite.



Non-destructive Testing (NDT) inspection station using C-scan water jets to determine voids in kevlar test panels for use on satellites.



Completed Boeing graphite epoxy Chebyshev filter assembly for Anik B and TDRSS communications satellites.

BRISTOL AEROSPACE LIMITED

**P.O. Box 874
Winnipeg, Manitoba
R3C 2S4**

Rocket Payloads, Telemetry, Data Collection Platform System

Bristol Aerospace, incorporated in 1930, has been involved in the development, manufacture and flying of instrumented payloads for 17 years. From this experience grew the capability to provide both satellite and ground-based data systems with outstanding reliability under severe environmental conditions.

Main Space Communications Systems, Proprietary Products and Services:

- Instrumented payloads
- Data collection platforms
- Geostationary operational environmental satellite transmitters
- Serial GOES transmitters
- ARGOS transmitters
- Serial ARGOS transmitters
- Weather stations
- Hydrology stations
- Emergency locator transmitter/
emergency position indicating radio beacon

Other Company Products and Services:

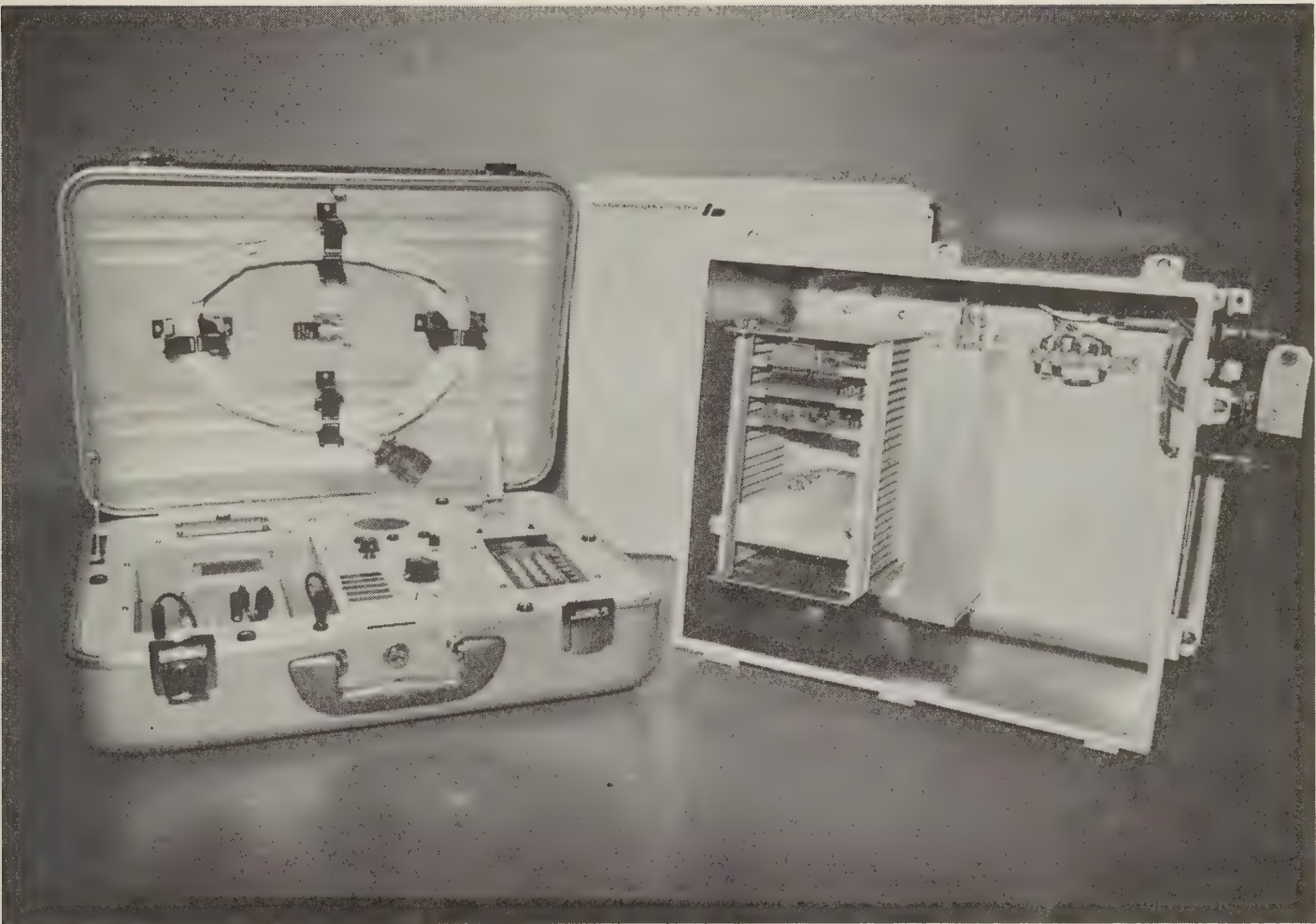
- Jet engine combustion and exhaust components
- Precision weldments or high temp stainless alloys cowlings, etc.
- Aircraft sheet metal assemblies
- Large light alloys aircraft structures
- Aircraft repair modification and overhaul
- Wind power turbine systems
- High altitude research rockets

Personnel: 1400

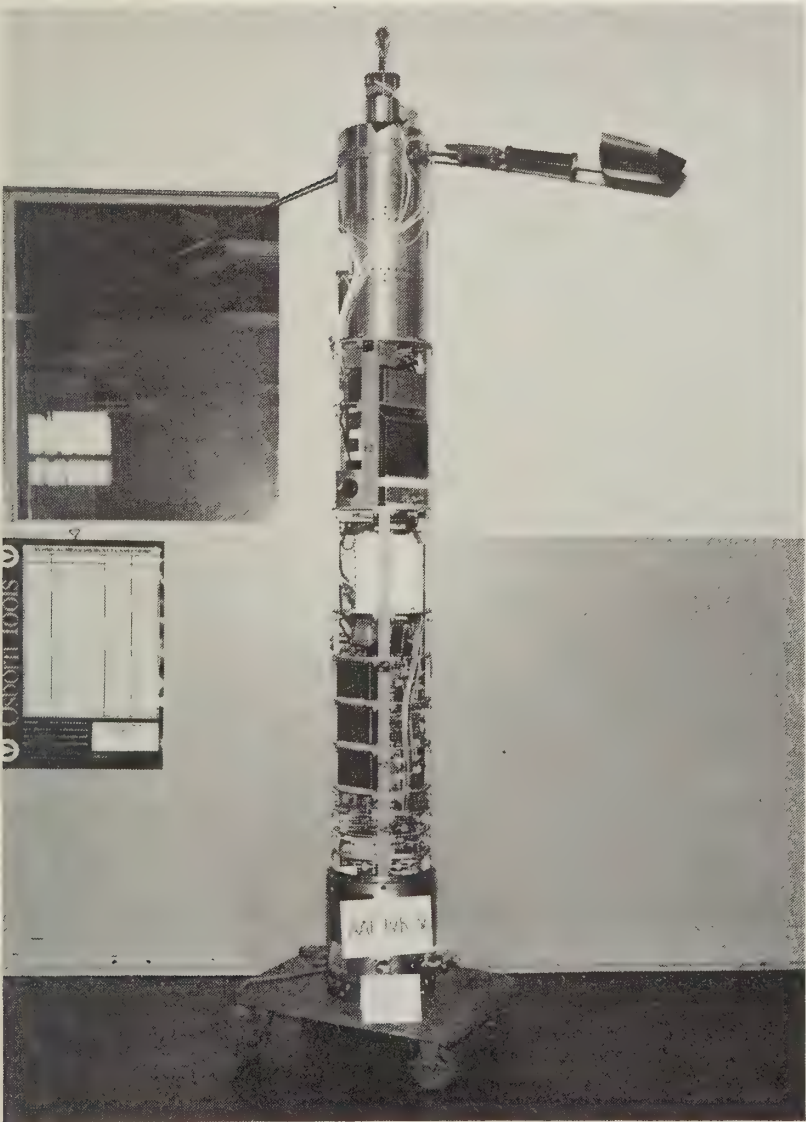
Annual sales: \$42 million in 1980

Contact:

**Mr. K.F. Burrows
Vice President, Marketing
Telephone: (204) 775-8331
Telex: 07-57774
TWX: 610-671-3598**



Bristol satellite data collection platform (right) and test set.



Bristol BBIV payload aboard this AAF-IV-36 launched from Churchill, Man, January, 1981 to obtain data on expansive phase of auroral substorm.

CANADIAN ASTRONAUTICS LIMITED

**1024 Morrison Drive
Ottawa, Ontario
K2H 8K7**

Ground Stations, Support Equipment, System Design

Founded in 1974 to provide space system design and planning services, the firm now has considerably expanded to develop and manufacture a wide range of electronic, computer, microwave and mechanical products.

Main Space Communications Systems, Proprietary Products and Services:

- High-Rel battery management subsystems
- SARSAT ground station (complete system, turn-key responsibility)
- Communications ground station equipment
- UV imager for Swedish Viking mission
- Vibration and thermal vacuum testing
- Mechanical ground support equipment
- System concept definition studies
- Preliminary system design and planning
- Launch and mission operations support

Other Company Products and Services:

- Airborne synthetic aperture radar
- EW radar simulator
- 3-D spectrum analyzer
- Mini and microprocessor systems
- Microwave antenna systems
- Industrial process control

Personnel: 95

Annual sales: \$6 million in 1980

Contact:

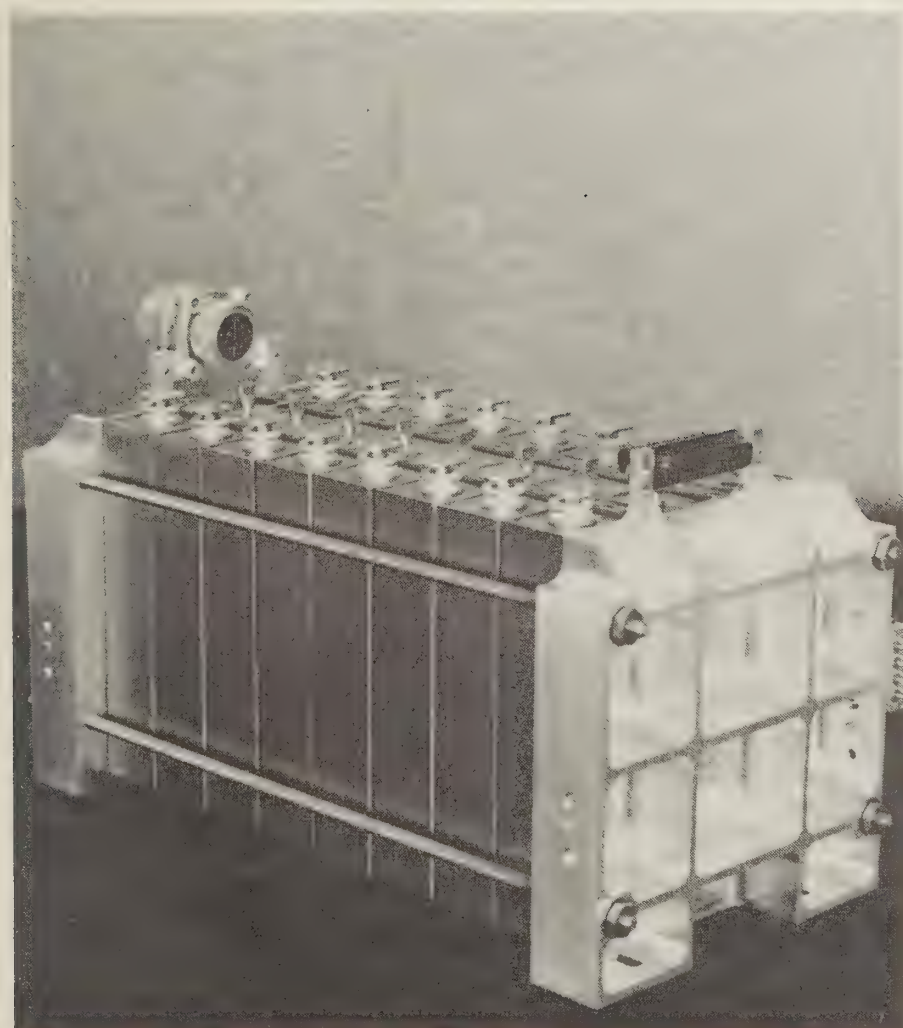
**J.D. Taylor
President**

Telephone (613) 820-8280

Telex: 053-3937



Artist's rendering of CAL Sarsat ground station.



CAL spacecraft battery pack, part of the firm's high reliability battery management subsystem.

CAE ELECTRONICS LTD.

**8585 Cote de Liesse
Saint Laurent, Quebec
H4T 1G6**

Remote Manipulation Components

An integrated design and manufacturing company of special purpose real-time computer based systems, airborne and space equipment.

Main Space Communications Systems, Proprietary Products and Services:

- Hand controllers and display panel for the Space Shuttle Remote Manipulator System
- Six-degree-of-freedom hand controllers

Other Company Products and Services:

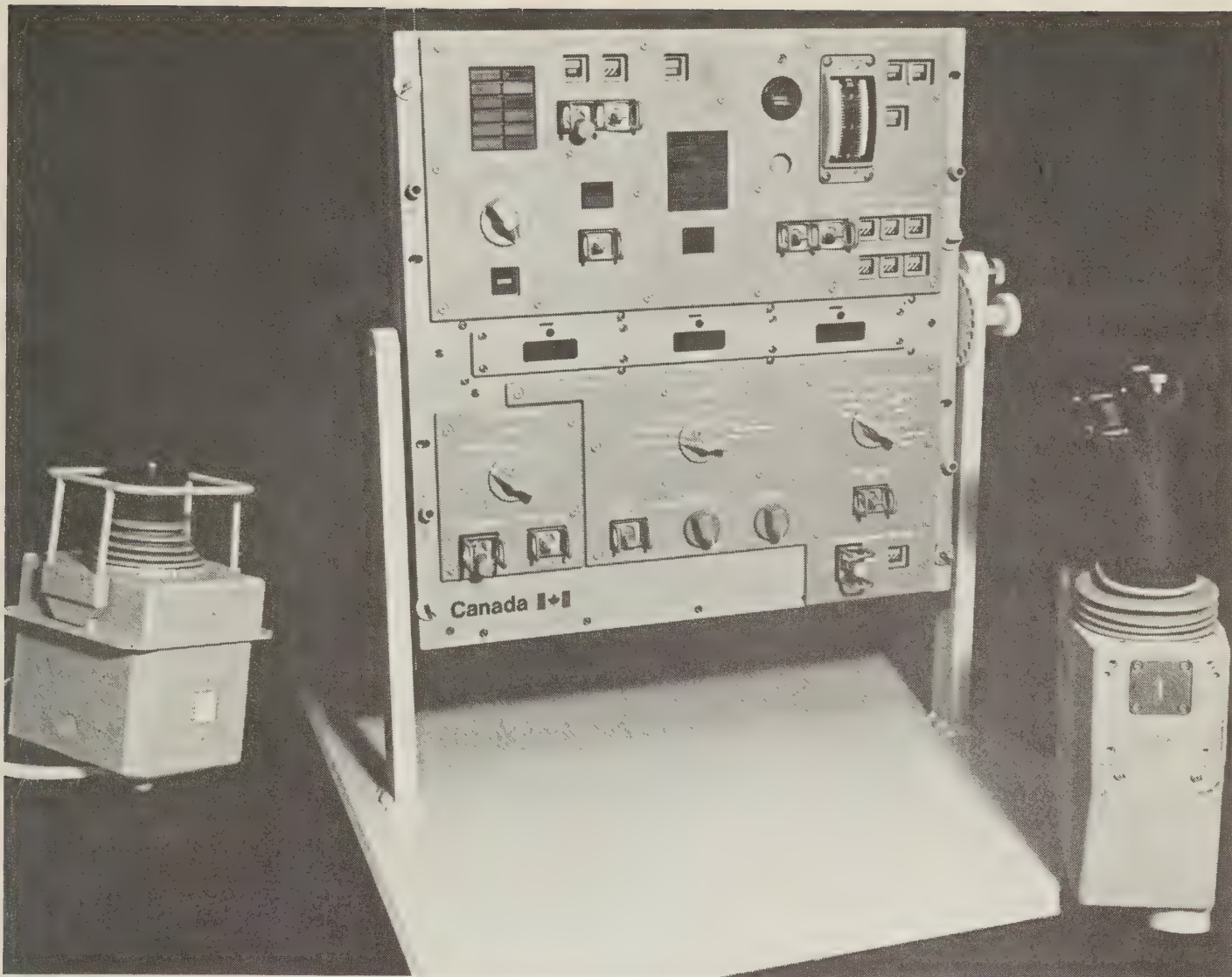
- Flight and tactical simulators
- Power station simulators
- DACS and SCADA systems for power utilities
- ASW Magnetic Anomaly Detection equipment (MAD)

Personnel: 1,650

Annual sales: \$80 million in 1980

Contact:

**Mr. D.R. Tait
Vice President, Technical
Development & Sales
Telephone: (514) 341-6780
Telex: CAE 05-824856
TWX: CAE MTL
610-422-3063**



Rotational and translation hand controllers with display and control used on NASA Space Shuttle orbiter to control Remote Manipulator arm.

CANADIAN MARCONI COMPANY

**2442 Trenton Avenue
Montreal, Quebec
H3P 1Y9**

Aerospace Electronic Equipment

Canadian Marconi Co. was incorporated in 1902, and now designs and manufactures electronic equipment for telecommunications, radar, ground and air navigation.

Main Space Communications Systems, Proprietary Products and Services:

- NAVSTAR/GPS user equipment

Other Company Products and Services:

- Antenna navigation systems
- Display systems
- Ground support systems
- Test systems

Personnel: 2250

Annual sales: \$113 million
in the fiscal year 79/80

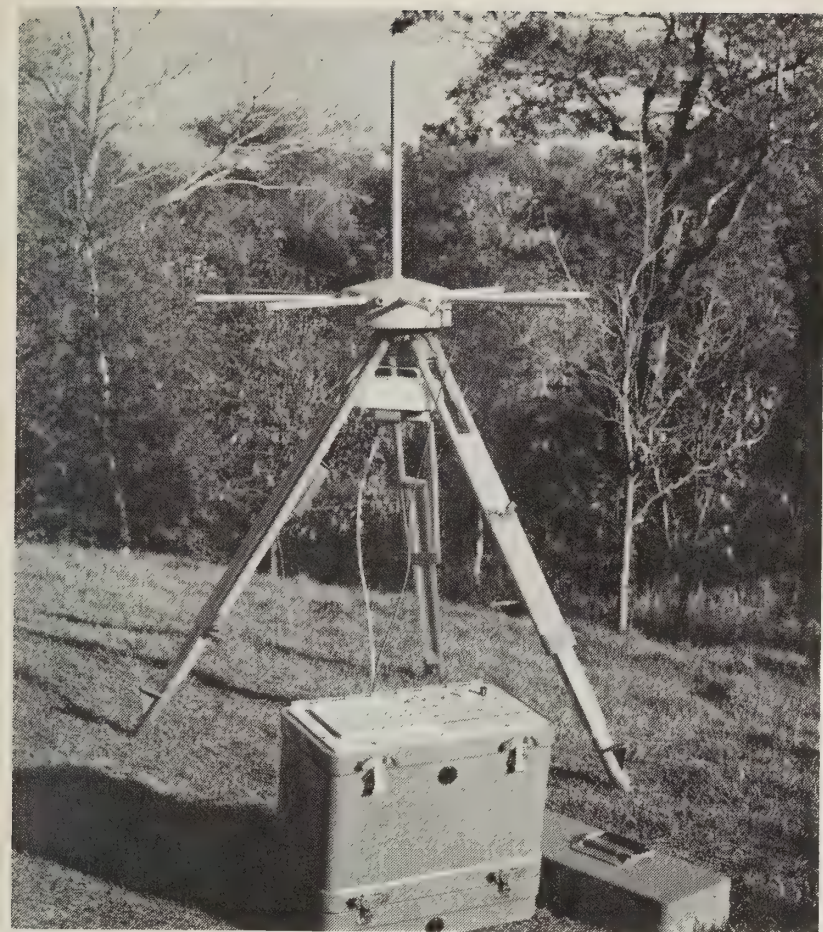
Contact:

Mr. W. Rosebery

Telephone (514) 341-7630

Telex: 05-827822

TWX: 610-421-3564



Typical satellite referenced precision-positioning equipment made by CMC for survey and navigational use.



CMC manufacturing operation for hybrid microcircuits for space-related and other applications.



General view of CMC clean aerospace assembly and test area in Montreal plant.

COM DEV LTD.

**155 Sheldon Drive
Cambridge, Ontario
NIR 7H6**

Satellite Communications Microwave Subsystems, Multiplexing Networks

Com Dev Ltd., incorporated in 1971, now houses R&D capability and a space qualified manufacturing facility for microwave subsystems with in-house computer controlled testing, vibration, thermal vacuum, high conductivity plating and N.C. machining. Customers include all major manufacturers of satellite systems.

Main Space Communications Systems, Proprietary Products and Services:

- Microwave multiplexing networks
- Variable power dividers and combiners
- High and low power ferrite devices
- Preselect and harmonic filters
- Group delay and amplitude equalizers
- Low loss antenna diplexers
- Antenna phase combiners and dividers
- High power couplers and terminations
- Tx and Rx reject filters

Other Company Products and Services:

- Consultant services for satellite transponder design
- Consultant services for high power segment of earth stations
- Consultant services for microwave signal processing

Personnel: 72

Annual sales: \$3.2 million in 1980

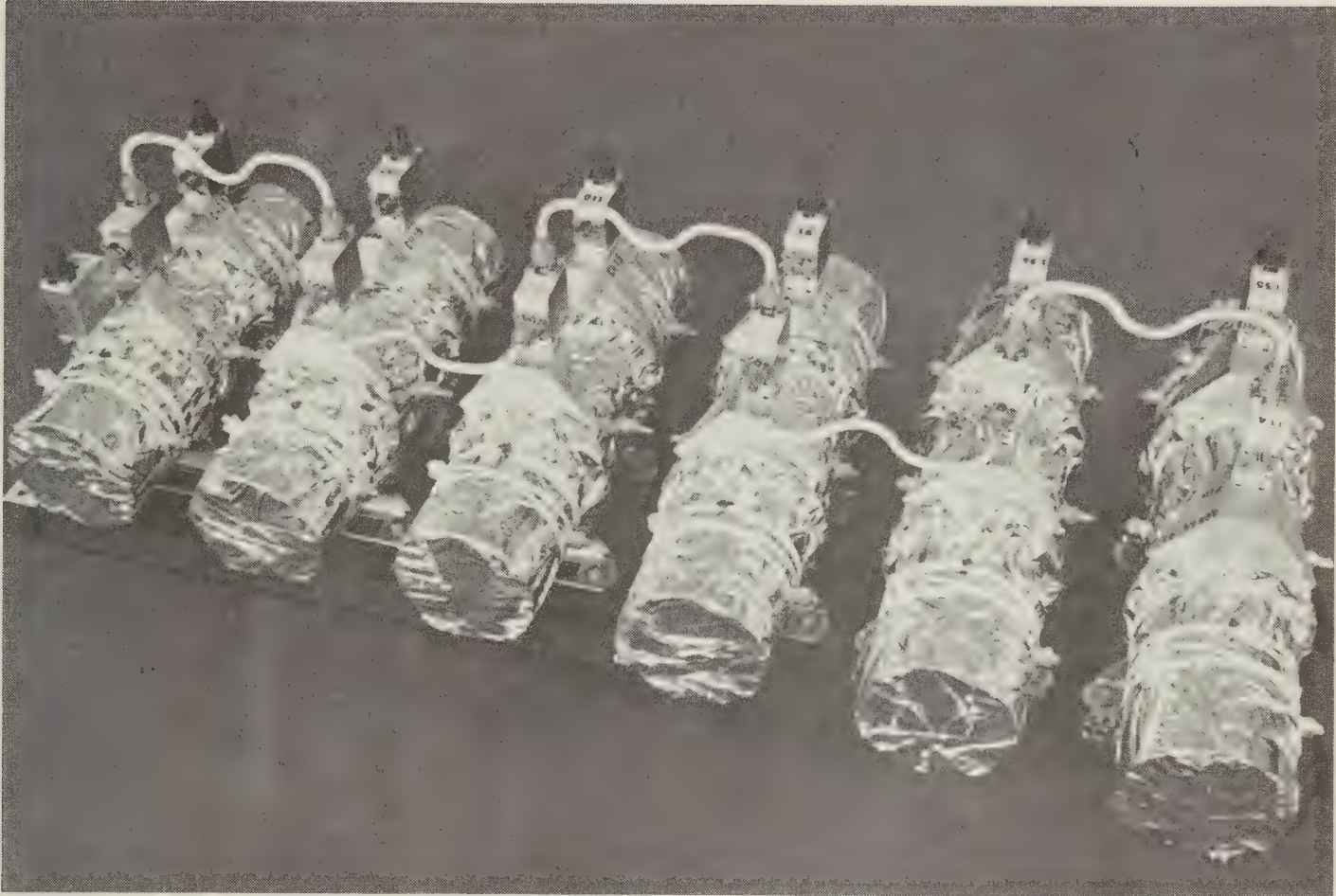
Contact:

Mr. M.V. O'Donovan

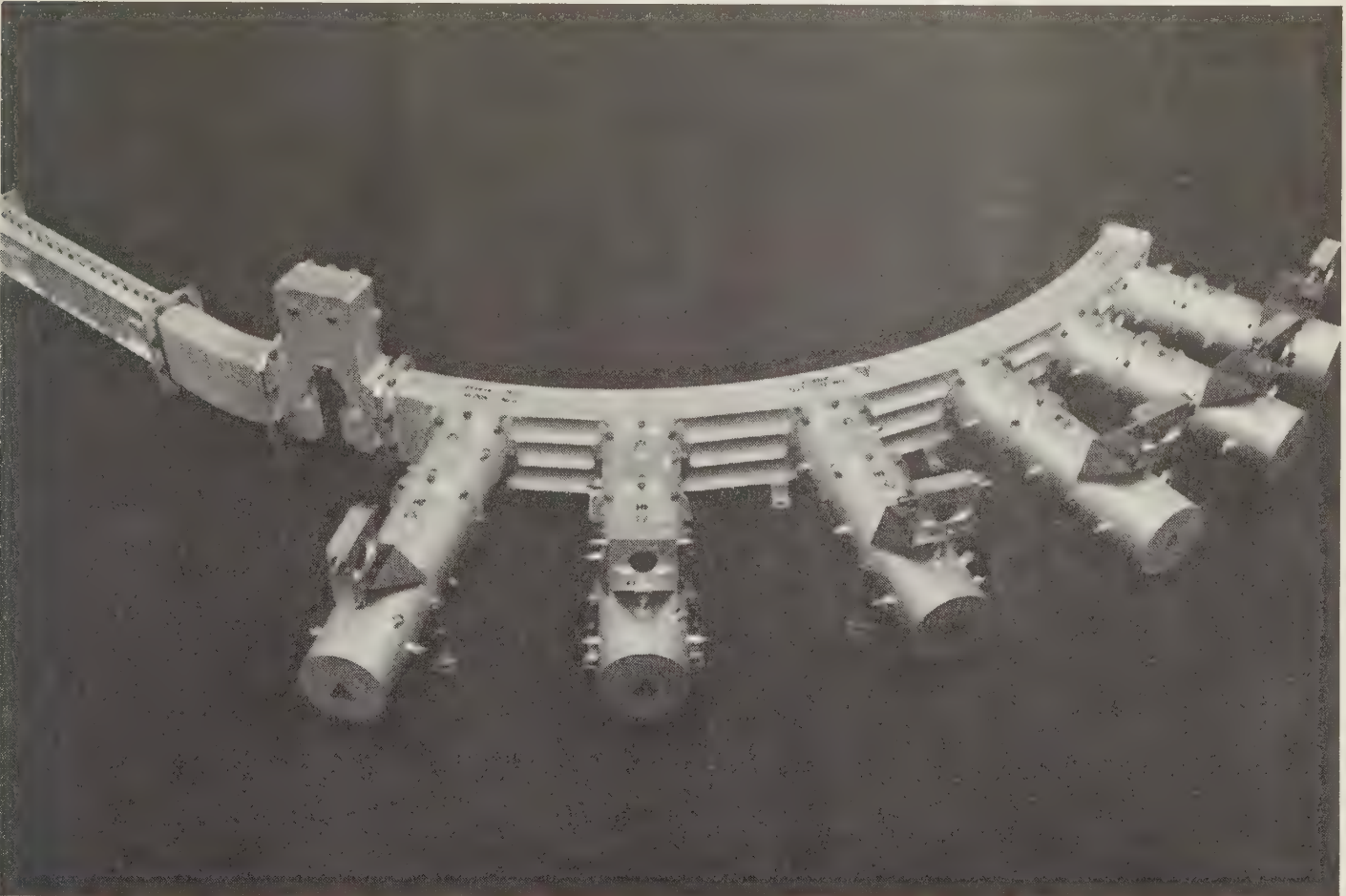
President

Telephone: (519) 662-2300

TWX: 610-366-3164



Com Dev six-channel 4 GHz 1/P multiplexer used on RCA SATCOM satellite series



Com Dev six-channel output 4 GHz multiplexing network for communications satellites

DIGITAL TELECOMMUNICATIONS LTD.

**1305 Matheson Boulevard
Mississauga, Ontario
L4W 1R1**

Earth Stations, Digital Communications Equipment

DTL, incorporated in 1974, designs and manufactures digital communications equipment. DTL can provide both single modules and turn-key systems.

Main Space Communications Systems, Propriety Products and Services:

- TDMA earth stations
- Transportable earth stations
- Digital voice encoding (PCM, CVSD)
- Multiplexers
- Voice, data & TTY channel units

Other Company Products and Services:

- Fiber optic equipment
- Digital video codecs
- Data interface

Personnel: 30

Annual sales: \$3 million in 1980

Contact:

Mr. W.G. Maillet

General Manager

Telephone: (416) 624-1810

TWX: 610-492-4728

FLEET INDUSTRIES, A DIVISION OF RONYX CORPORATION LTD.

**P.O. Box 400, Gilmore Road
Fort Erie, Ontario
L2A 5N3**

Specialized Satellite Structures

Fleet Industries is involved in the production of solar array substrates, equipment shelves for satellites and performs composite technology bonding.

Main Space Communications Systems, Proprietary Products and Services:

- Specialized structures for use aboard satellites

Other Company Products and Services:

- Aircraft component subcontractor

Personnel: 980

Annual sales: \$30 million in 1980

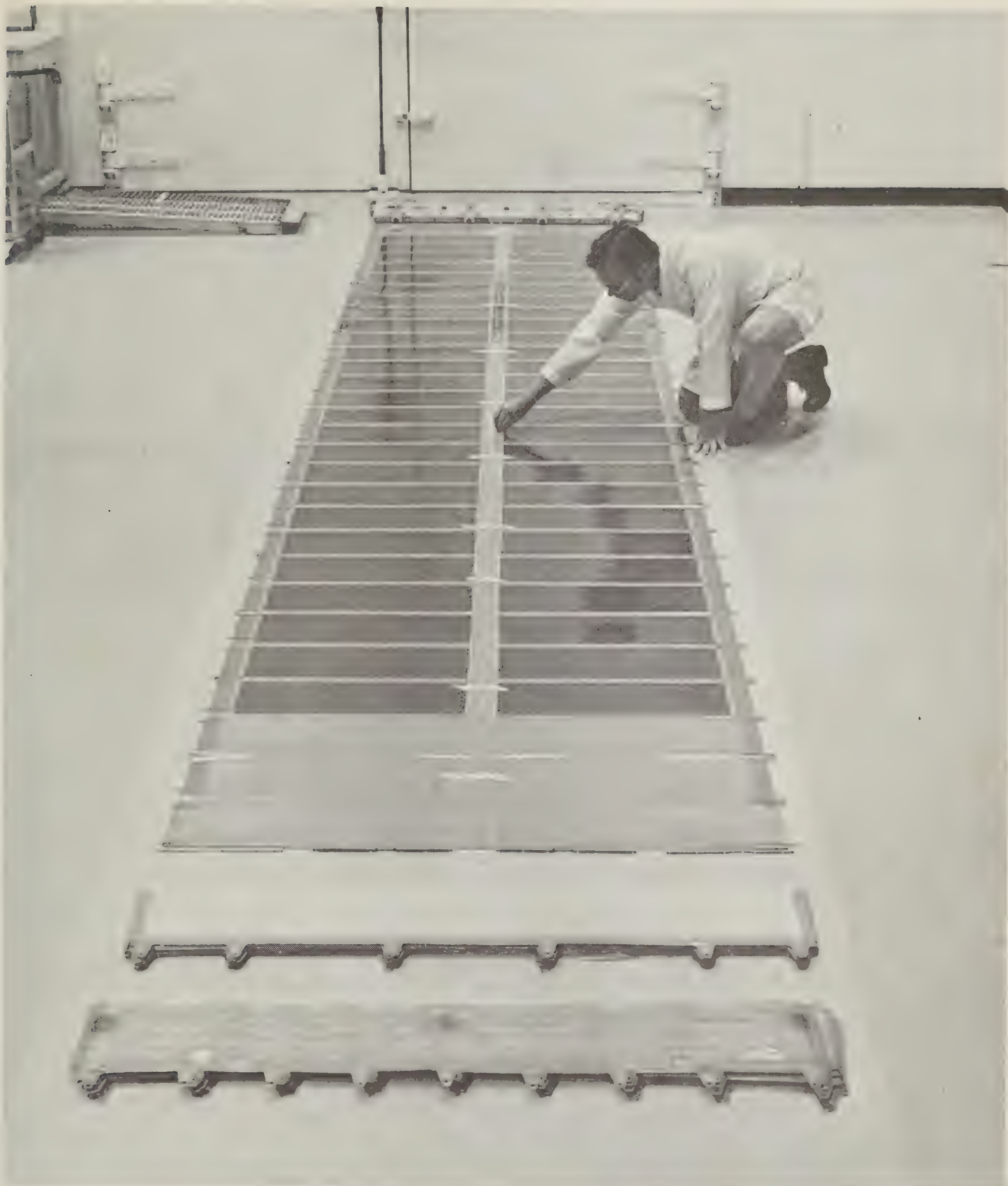
Contact:

**Mr. H.B. MacRitchie
Sales Manager**

Telephone: (416) 871-2100

Telex: 061- 5165

TWX: 610-373-0101



A technician at the Communications Research Centre at Shirley's Bay inspects segments of a solar array used on the Hermes spacecraft.

GENSAT COMMUNICATIONS CORPORATION

**809 Wellington St.N.
Kitchener Ontario
N2G 4J6**

Satellite Earth Terminals

Gensat, incorporated in 1981, concentrates its efforts on the international private satellite television earth terminal market through its parents, Electrohome Ltd. and Microdesign Ltd. Electrohome Electronics has strong expertise in video related products while Microdesign specializes in microprocessor-based products for the communications industry.

Main Space Communications Systems, Proprietary Products and Services:

- 12 GHz agile receiver
- 4 GHz microprocessor-controlled agile receiver
- Microprocessor-controlled antenna controller
- Satellite receiver test generator

Other Company Products and Services:

- Video monitors, Telidon terminals
- Custom assembly
- Cable TV videotex systems
- Sub-fractional HP motors
- Deilcraft furniture
- Microprocessor research and development services

Contact:

Electrohome:

Mr. Allan Lodberg

Telephone: (519) 744-7111

Telex: 069-55449

Microdesign:

Dr. Robert Arn

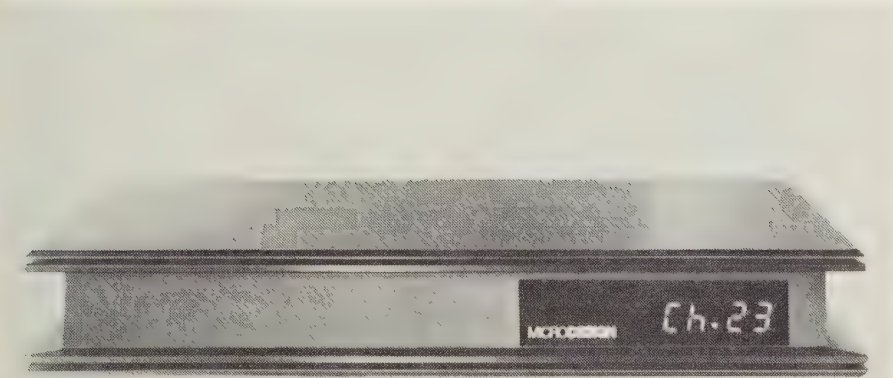
Telephone:(416) 992-4180



Electrohome completely metered 12 GHz manually tuned home receiver.



Electrohome TVRO generator of test signals to verify functionality of satellite receiver with 1 GHz and 4 GHz outputs.



Microdesign microprocessor-controlled 4 GHz automatic antenna controller with polar and polarization mode. Key pad for use with controller and Electrohome 4 GHz receiver.

HITECH CANADA LIMITED

**Suite 103, #68 Highway 7
Ottawa, Ontario
K2H 8P5**

Communications and Computer Systems Engineering

HiTech incorporated in 1973, is a growing company supplying systems engineering and computer-based products and services. The company established manufacturing capabilities in 1981.

Main Space Communications Systems, Proprietary Products and Services:

- Telemetry and command systems
- Data handling systems (hardware and engineering)

Other Company Products and Services:

- Monitoring and control systems
- Database systems
- Radar systems engineering
- Signal processing
- Optical character recognition

Personnel: 40

Annual sales: \$1.5 million in 1980

Contact:

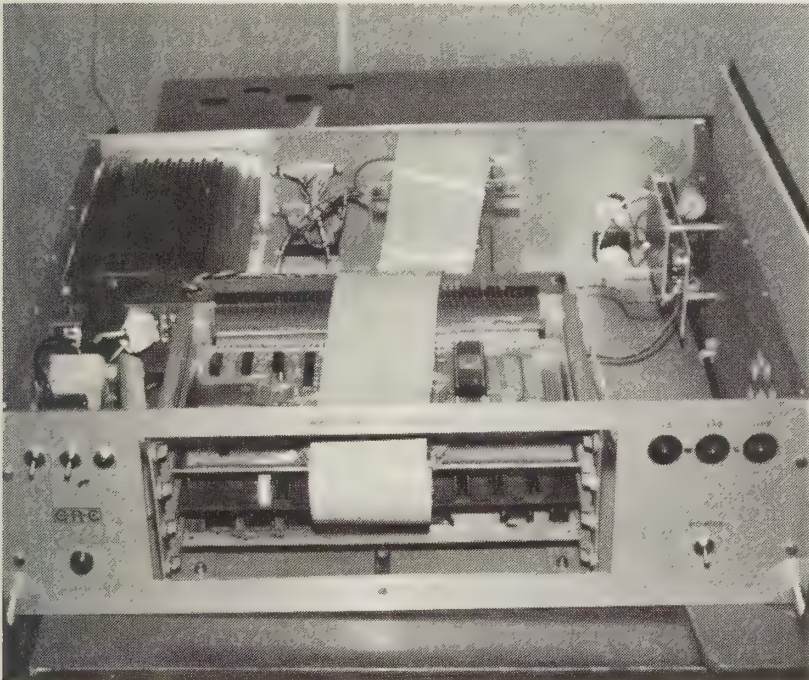
Mr. A.J. Kittridge

Telephone: (613) 820-1200

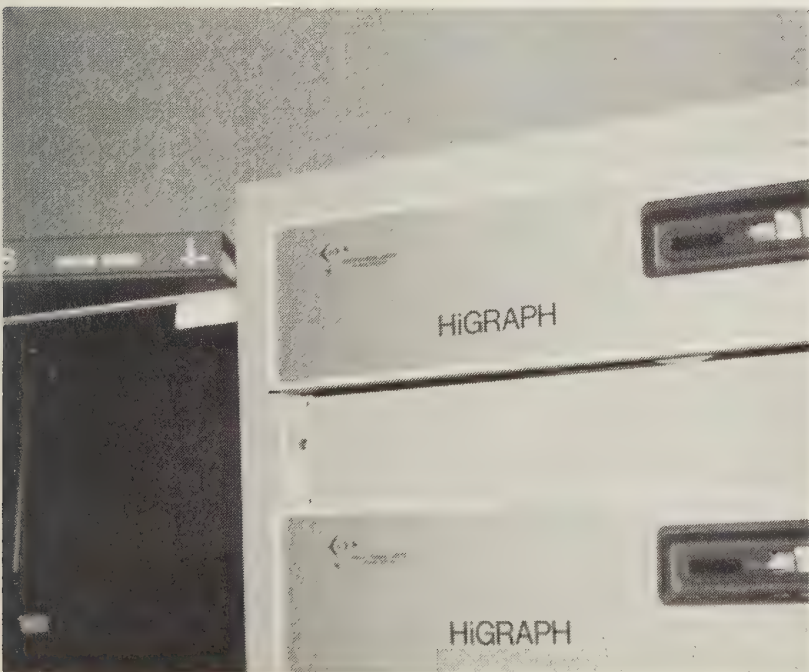
Telex: 053-3262



HiTech DFL data acquisition system during installation and acceptance at the Communications Research Centre at Shirley's Bay, Ont. using a PDP 11/60 computer with a PDP 11/34 as back-up.



Stand-alone HiTech spacecraft telemetry decommutation system used on board Anik C and Anik D satellites for display of command and control data.



Stand-alone graphics systems contained in HiTech data acquisition systems of up to three real and one non-real time graphs.

LINDSAY SPECIALTY PRODUCTS

**50 Mary St. West
Lindsay, Ontario
K9V 4S7**

Earth Stations and Accessories

Lindsay Specialty Products was incorporated in 1953 and is actively involved in the TVRO earth station market, supplying earth stations, antennas, receivers and accessories.

Main Space Communications Systems, Proprietary Products and Services:

- TVRO earth stations
- Antennas, receivers, LNAs and accessories.

Other Company Products and Services:

- CATV remote cordless convertors
- High frequency welding

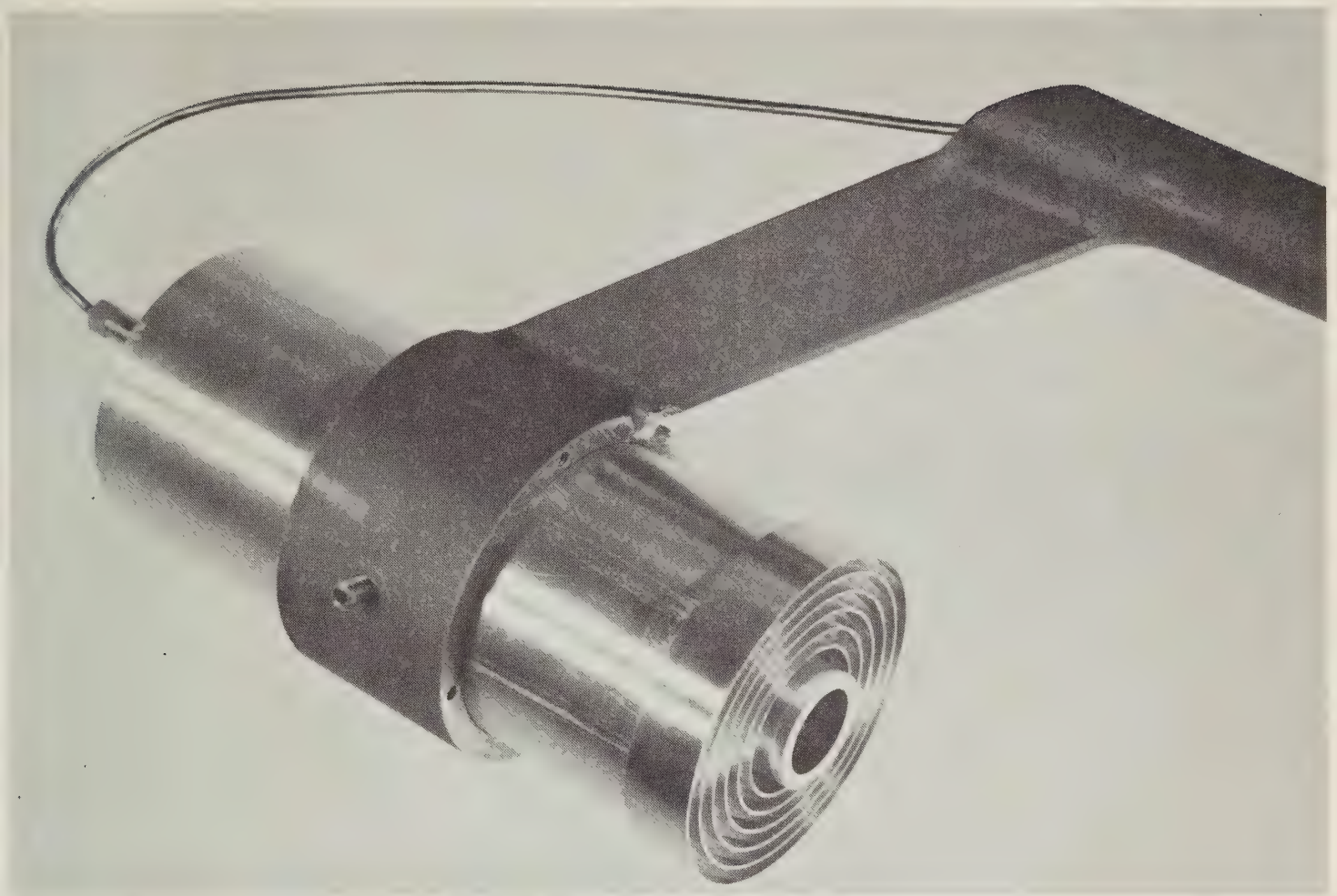
Personnel: 500

Contact:

**Mr. John Thomas
President**

Telephone: (705) 324-2196

Telex: 06-962-860



This prototype 12 GHz low noise amplifier was developed at the Communications Research Centre as part of a 60 cm parabolic antenna for the Hermes and Anik B programs of the Department of Communications.

MacDONALD DETTWILER & ASSOCIATES LTD.

**3751 Shell Road
Richmond, B.C.
V6X 2Z9**

Satellite Processing Systems

MDA Ltd. is a manufacturer of ground stations and equipment for receiving and processing data from earth sensing satellites.

Main Space Communications Systems, Proprietary Products and Services:

- Meteorological satellite ground stations
- Landsat ground stations
- Satellite image analysis system
- Synthetic aperture radar processors
- Laser Film recorders

Other Company Products and Services:

- Airline flight operations systems
- HF data modem
- Cable TV signal processing
- Airborne SAR processors

Personnel: 200

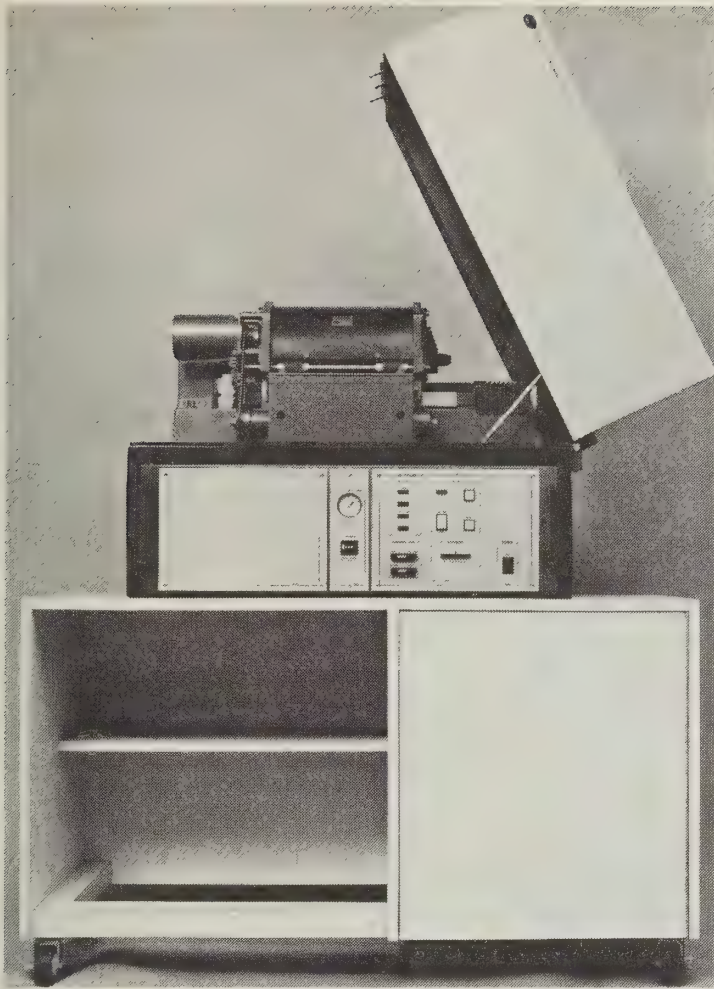
Annual sales: \$12 million in 1980

Contact:

Mr. Marshall Prentice

Telephone: (604) 278-3411

Telex: 04-355599



MDA FIRE-20 laser beam film recorder for processing imagery of sensing satellites.



MDA LANDSAT receiving site located at Alice Springs, Australia, including receiving and processing station.

MA ELECTRONICS CANADA LIMITED

**3135 Universal Drive
Mississauga, Ontario
L4X 2E7**

Microwave Components, Amplifiers and Subsystems

Founded in 1977, MA Electronics now manufactures microwave components for terrestrial communications and satellite earth terminals, with design and manufacturing facilities for all passive and active devices, including low noise amplifiers.

Main Space Communications Systems, Proprietary Products and Services:

- 4 GHz low noise amplifier for TVROs
- 12 GHz low noise amplifier for TVROs
- 14 GHz 1 watt amplifier for telephony uplinks
- 12 GHz redundant LNA subsystems
- 4 GHz LNA downconverters
- High power combining systems
- High power diplexers
- High power terminations
- Power dividers and combiners

Other Company Products and Services:

- Waveguide ferrite devices
- Coaxial ferrite devices
- Waveguide and coax filters
- Transformer, transitions and transducers
- Attenuators (manual and power), terminations
- PIN diode switches and attenuators

Personnel: 51

Annual sales: \$1.5 million in 1980

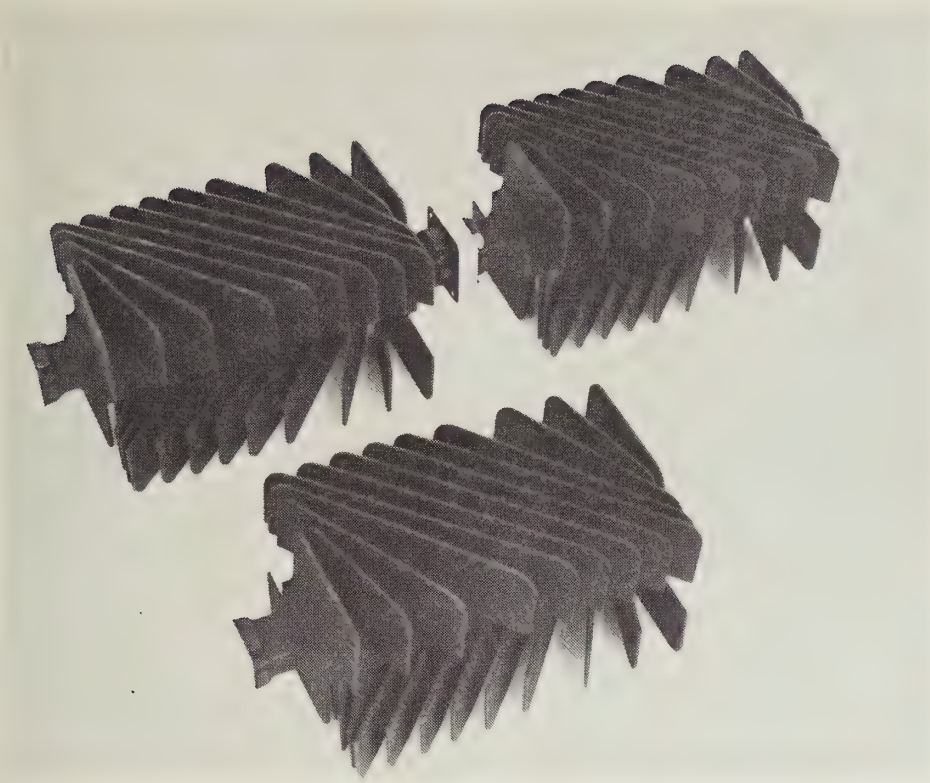
Contact:

Mr. Brian Dinsdale

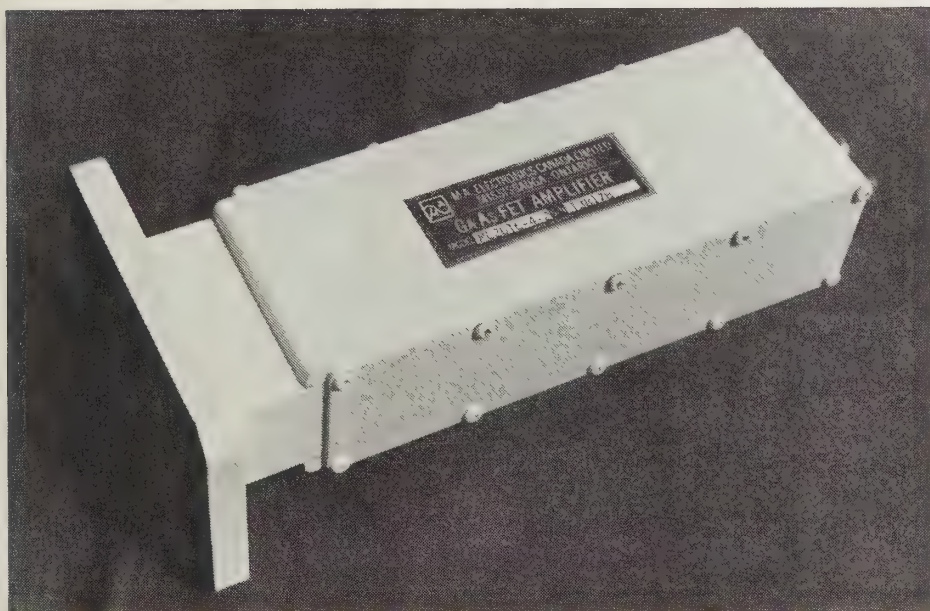
Sales Manager

Telephone (416) 625-4605

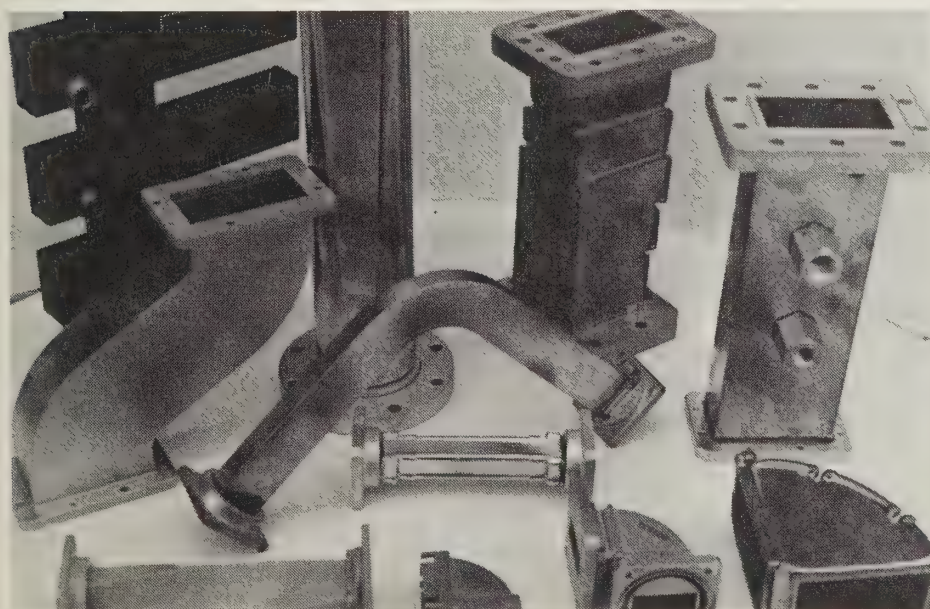
TWX: 610-492-4317



MA Electronics high power terminations and attenuators for 6 and 14 GHz uplink applications.



MA Electronics, 3.7-4.2 GHz GaAs low noise amplifier designed for small earth station applications.



MA Electronics transmission line devices including straight-forward microwave hardware and complex components.

MICROWAVE INSTRUMENTS & COMPONENTS INC

**6600 Bombardier Street
Montreal, Quebec
H1P 1E4**

Waveguide Components

Microwave components for telecommunications applications.

Main Space Communications Systems, Proprietary Products and Services:

- Waveguide components for transmission lines

Personnel: 20

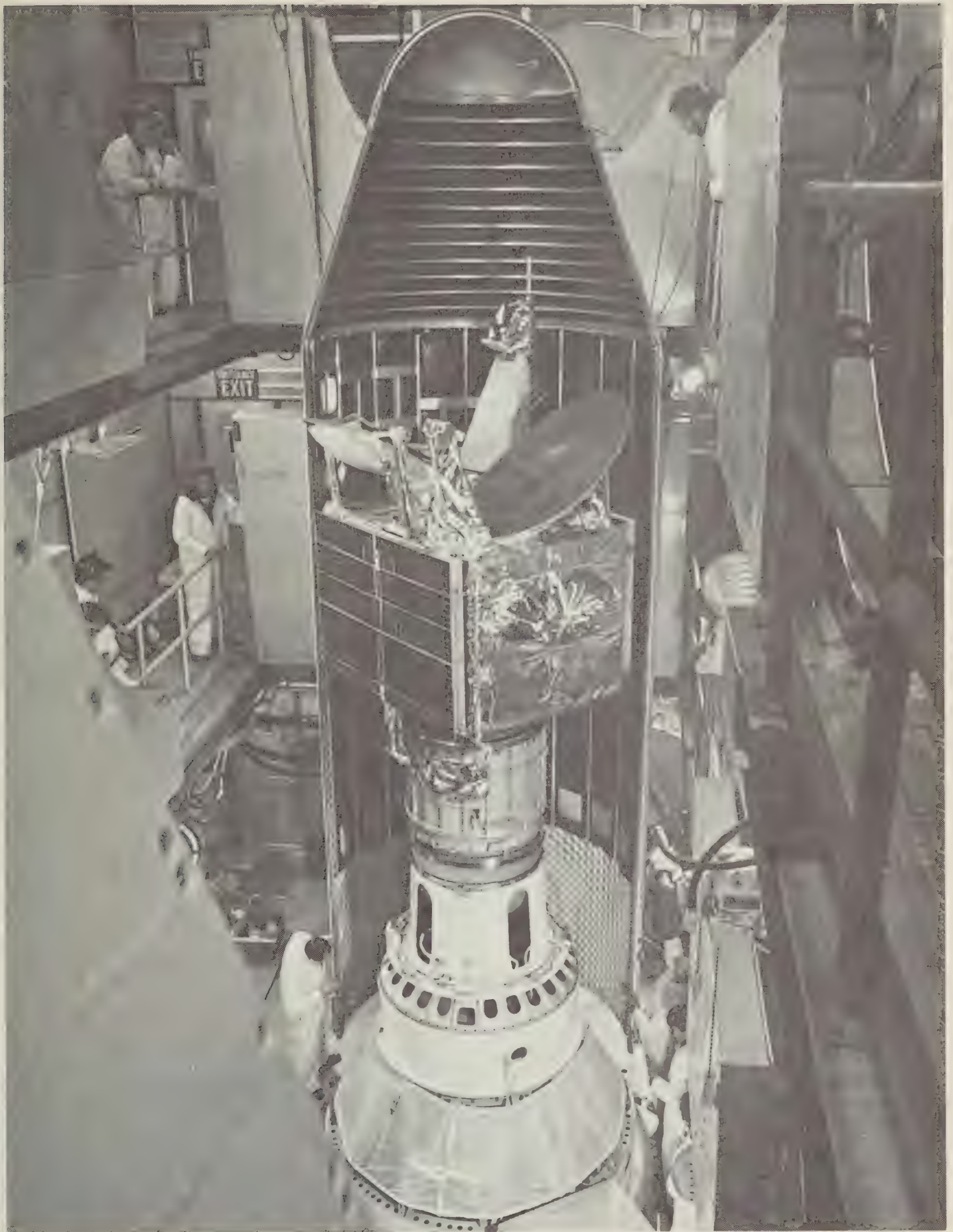
Annual sales: \$0.7 million in 1980

Contact:

Mr. R. Gentner

Telephone: (514) 321-3680

TWX: 610-421-3301



Telesat Canada's Anik B satellite was launched by the US National Aeronautics and Space Administration (NASA) in December, 1978, following extensive testing, including this weigh-in at the Delta Spin Test Facility on Cape Canaveral Air Force Station.

MILLER COMMUNICATIONS SYSTEMS LTD

**300 Legget Drive
Kanata, Ontario
K2K 1Y5**

Satellite Communications Systems Engineering

The firm was founded in 1974 as an engineering company specializing in the planning, design and implementation of a wide range of communications systems and associated automatic testing systems.

Main Space Communications Systems, Proprietary Products and Services:

- Light route TDMA terminals
- Network engineering
- Software programs for transmission planning
- Modulation and coding studies
- Communications systems design definition
- Consultants in advanced systems
- Automatic carrier monitoring systems

Other Company Products and Services:

- Demand assignment systems (SCPC)
- Spread spectrum modems
- Digital modems

Personnel : 55

Annual sales: \$2 million in 1980

Contact:

Dr. R. G. Lyons

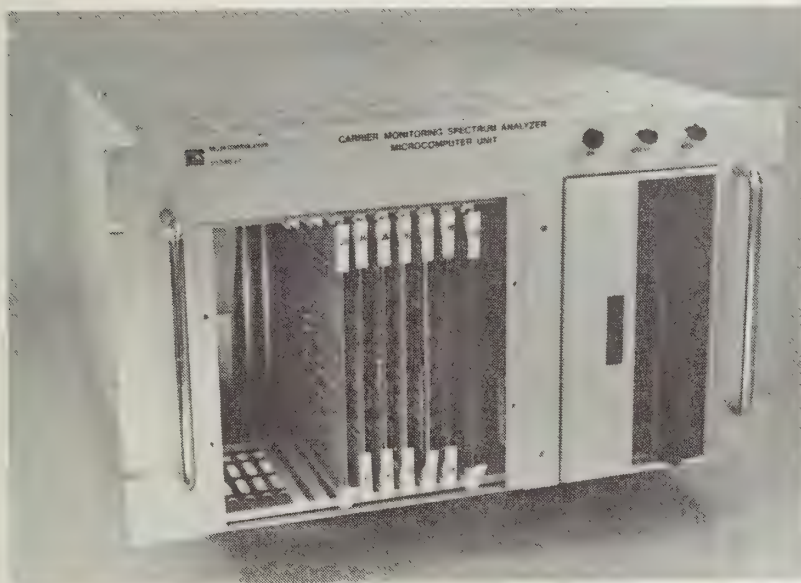
**Director of Advanced
Systems**

Telephone: (613) 592-3020

Telex: 053-4164



Miller developed single-channel-per-carrier channel unit mobile terminal for use with UHF communications satellite to provide field quality voice, and synchronous and asynchronous data transmission resulting from the MUSAT program.



Miller developed carrier monitor system for measurement of carrier amplitude frequency spectral shape and carrier-to-noise ratio for signals ranging from SCPC to video to TDMA.



Hand-carried receiving units used in Canada's sub-orbital rocket program at Churchill, Manitoba for tracking spent payloads.

MONITEQ LTD.

**630 Rivermede Road
Concord, Ontario
L4K 1B6**

Remote Sensing Applications and Instrumentation

Moniteq was founded in 1976 to develop new applications in monitoring environmental quality. Electro-optical instrumentation complements interpretive software for oceanographic and atmospheric applications. It has both hardware and software development facilities.

Main Space Communications Systems, Proprietary Products and Services:

- Image processing software
- Electro-optical sensors for monitoring atmospheric radiation, pollution for remote sensing and in-situ measurement
- Program definitions
- Scientific feasibility studies
- Algorithm development
- Oceanographic imagery analysis
- UV VIS IR remote sensors
- Altimeter studies

Other Company Products and Services:

- Ambient and remote sensors for air quality
- Airborne surveys and software for water quality and depth
- Nerve agents detection device
- Air quality monitoring
- Atmospheric scattering and attenuation measurements
- Image correction and analysis

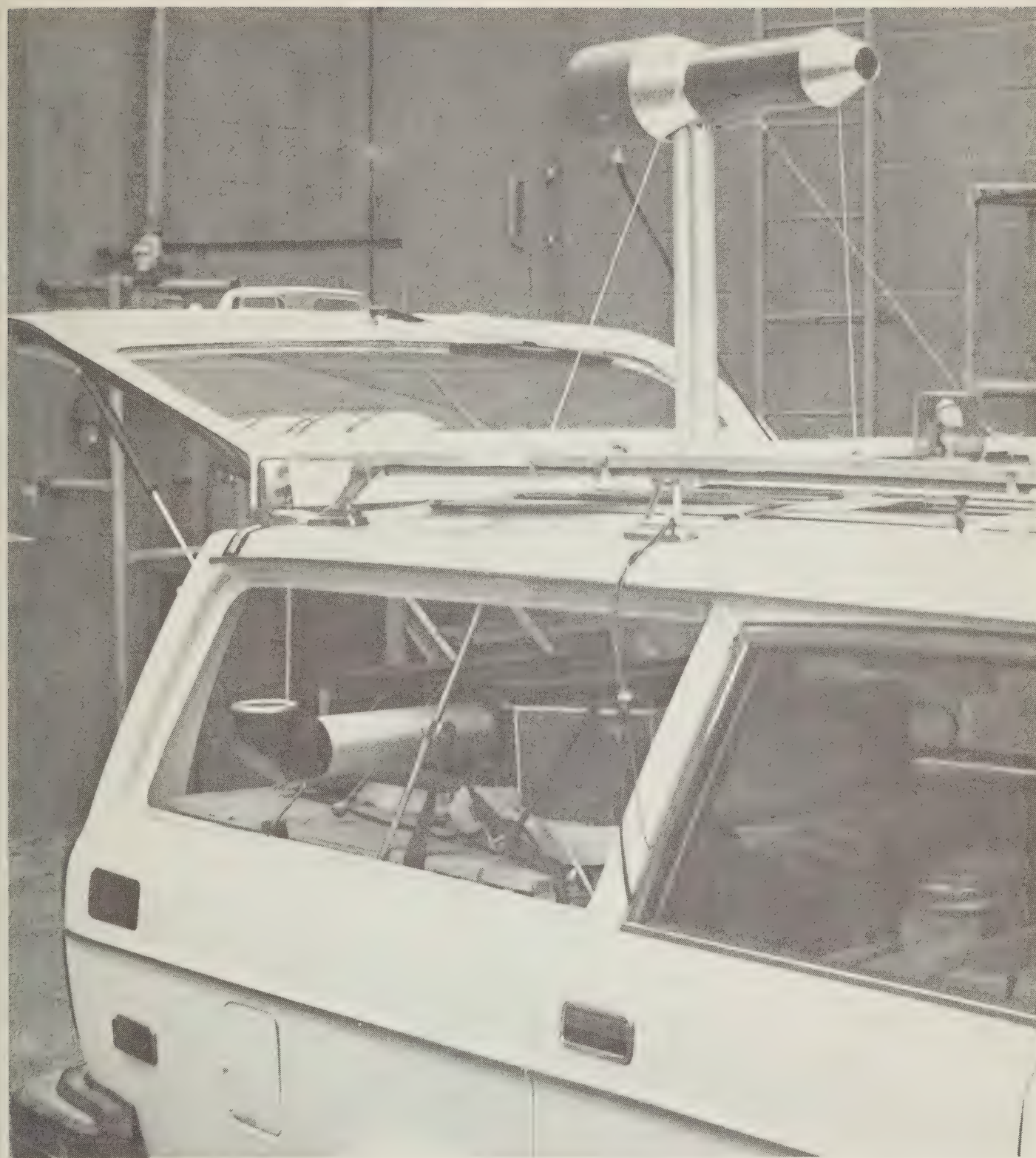
Personnel: 31

Annual sales: \$1 million in 1980

Contact:

Mr. D.A. Whiteman

Telephone: (416) 669-5334



Air intake for fast response mobile SO₂ ambient monitor, mounted atop automobile with PLUMETRACKER.

MPB TECHNOLOGIES INC.

**P.O. Box 160, 21051 N. Service Road
Ste Anne de Bellevue, Quebec
H9X 3L5**

R & D and Specialized Products

The company was founded in 1976 as a R&D activity and has expanded into a number of unique products. It has manufacturing facilities for specialized systems and products.

Main Space Communications Systems, Proprietary Products and Services:

- Electronic design-modems, bit synchronizers
- TDMA analysis and design
- Microprocessor applications
- Signal and data processing and software
- Antenna development
- Propagation analysis: satellite-earth
- Scientific experimenter-hardware interface
- Microwave, mm wave and optical devices and design
- Radar scattering and interaction

Other Company Products and Services:

- Microprocessor controllers
- Electronic graphic and display systems
- Long life CO₂ lasers and instrumentation
- Laser communications systems
- Sea-ice thickness measuring radars
- Microwave instrumentation

Personnel: 30

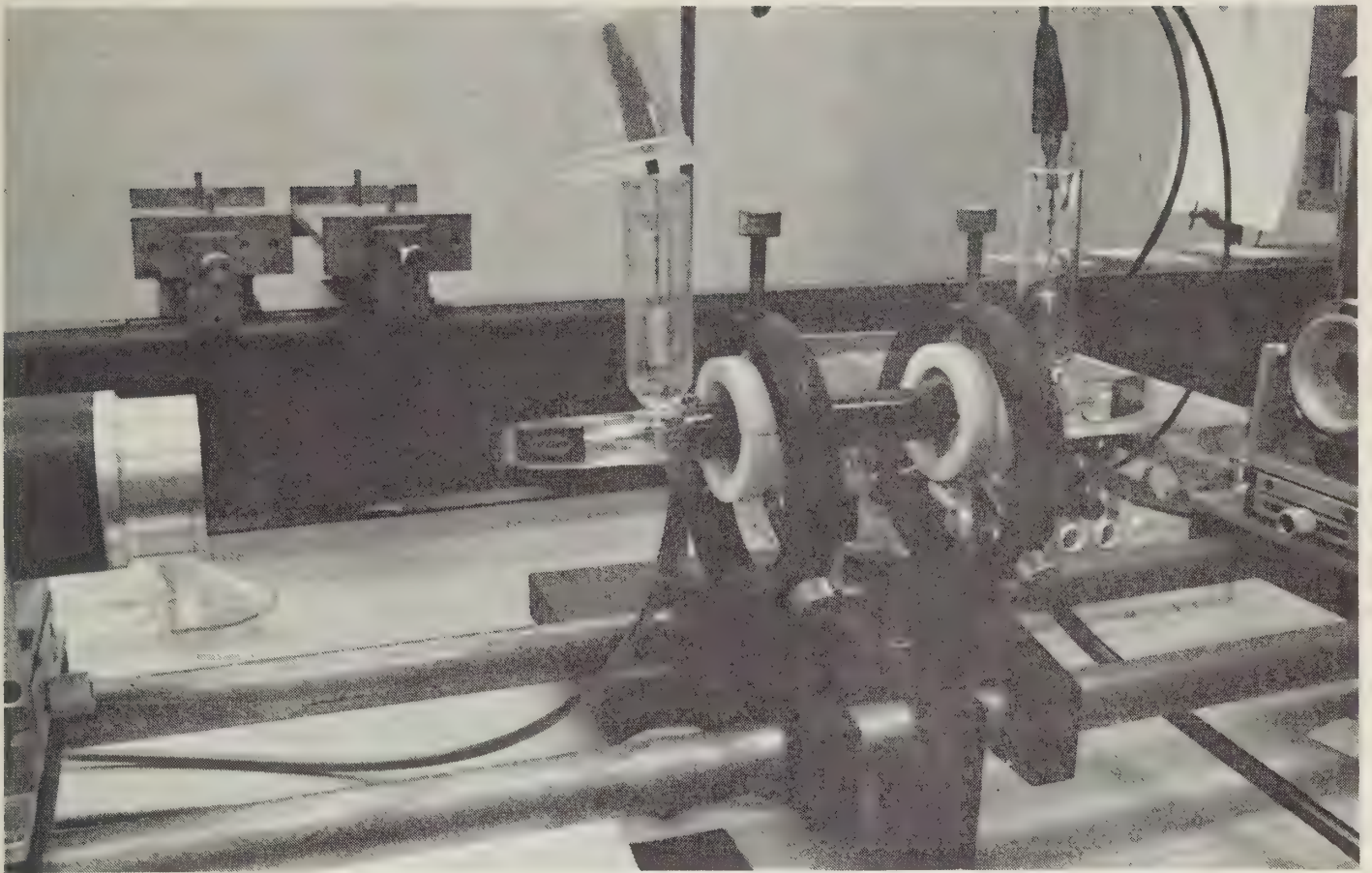
Annual sales: \$1.5 million in 1980

Contact:

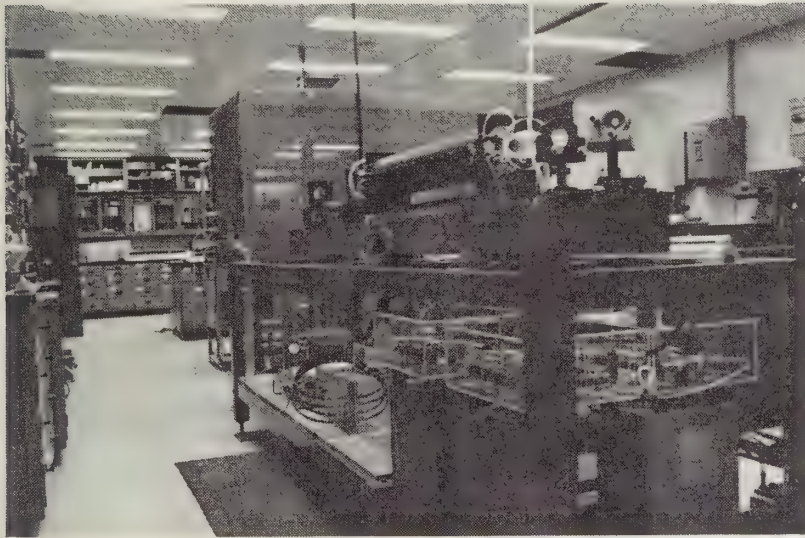
Dr. Morrel P. Bachynski

Telephone: (514) 457-2035

TWX: CABLE MPBT CAN



A microprocessor-based display controller for system monitoring applications.



An aperture injection-locked atomic iodine laser for use in plasma physics experiments.



A long life CO_2 waveguide laser under development for possible spacecraft-borne laser radar.

MUIRHEAD SYSTEMS LIMITED

**50 Galaxy Blvd. Unit #4
Rexdale, Ontario
M9W 4Y5**

Meteorological Satellite Receiving Systems

The company manufactures a range of products employed in the reception and processing of imagery from meteorological satellites.

Main Space Communications Systems, Proprietary Products and Services:

- Tiros-N APT receiving stations
- Earth station image recorders
- Image processors

Other Company Products and Services:

- Data switching and distribution systems
- Computer facsimile interfaces

Personnel: 20

Annual sales: \$2 million in 1980

Contact:

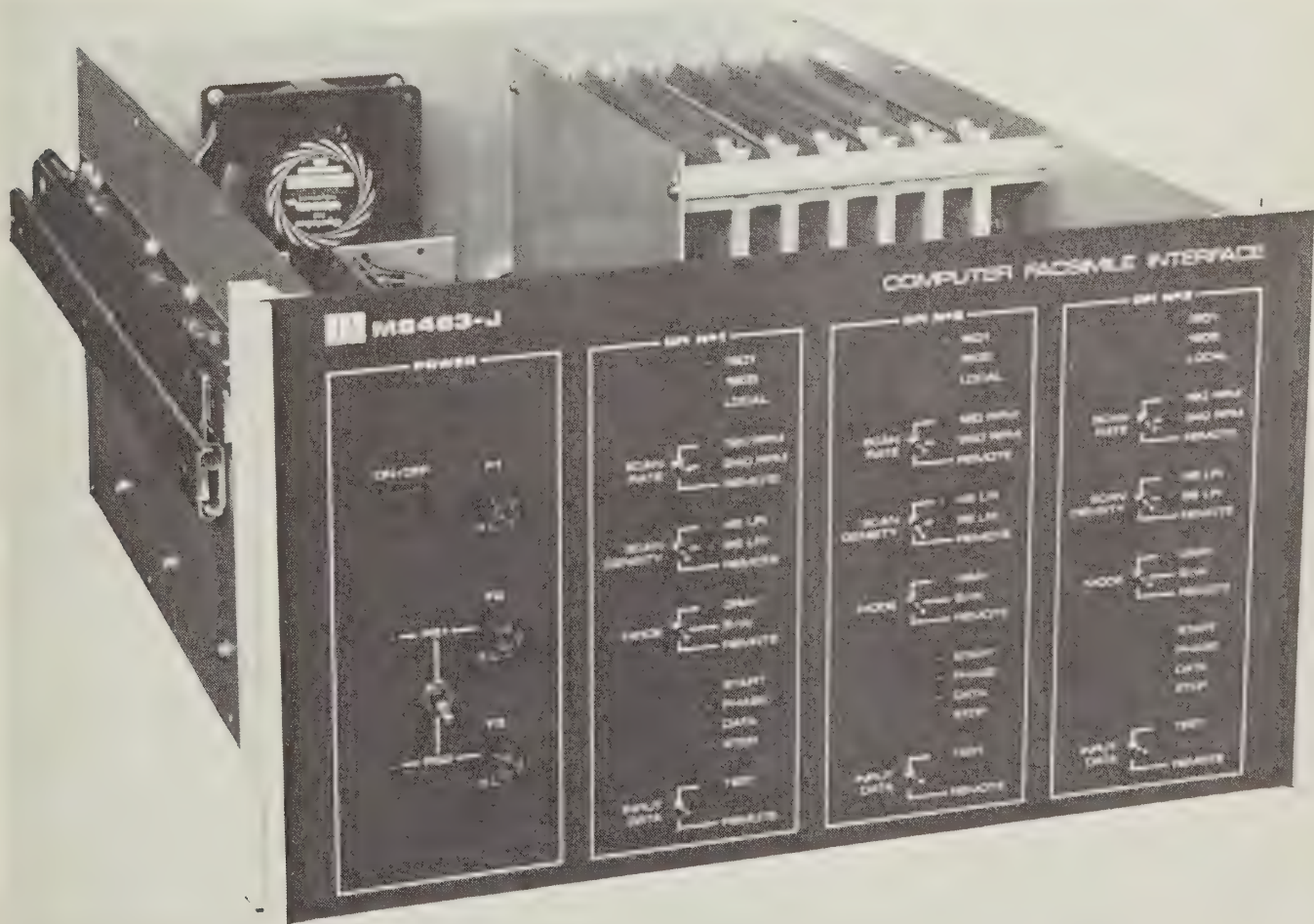
Mr. J.B. Crampton

Telephone (416) 675-7450

Telex: 06-989264



Muirhead satellite signal processor for reception of analog signals for APT from Tiros-N satellite.



QRL ANALYSIS CORPORATION

**19 Grenfell Crescent, Suite 100
Nepean, Ontario
K2G 0G3**

Material and Reliability Engineers

The company was founded in 1979 and employs former members of the Canadian government's High Reliability Laboratory to provide materials, reliability and failure analysis of electronic components, including destructive physical analysis.

Main Space Communications Systems, Proprietary Products and Services:

- Reliability studies
- Component analysis
- Failure analysis
- Quality assurance

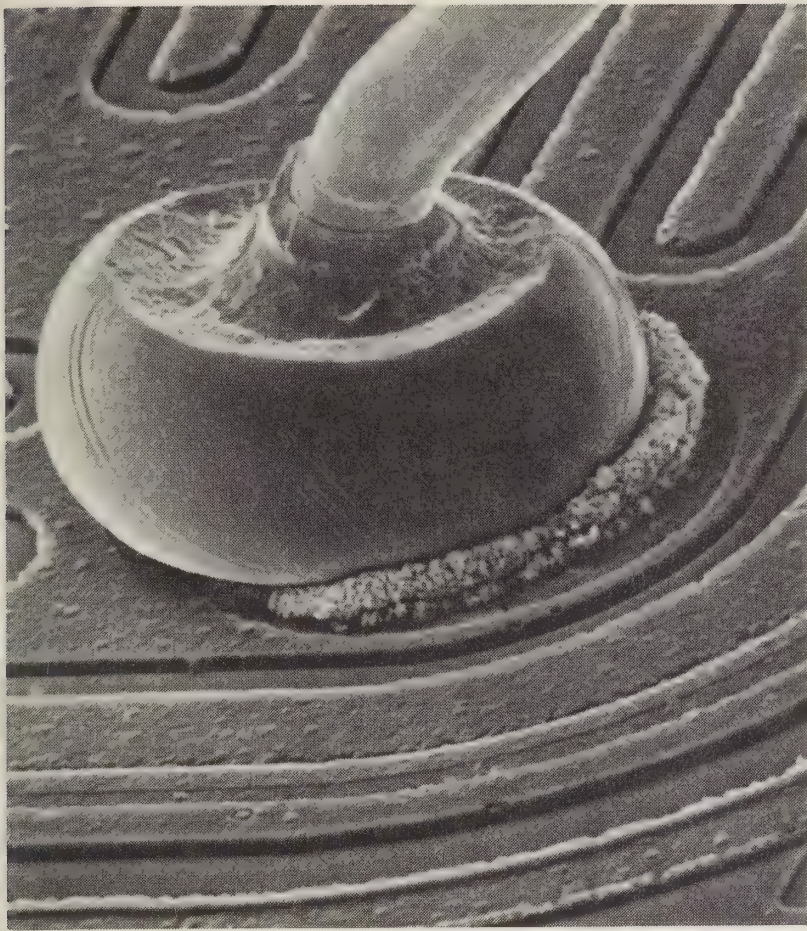
Other Company Products and Services:

- Materials analysis
- Quality audits
- Electron microscopy

Personnel: 5

Annual sales: \$150,000

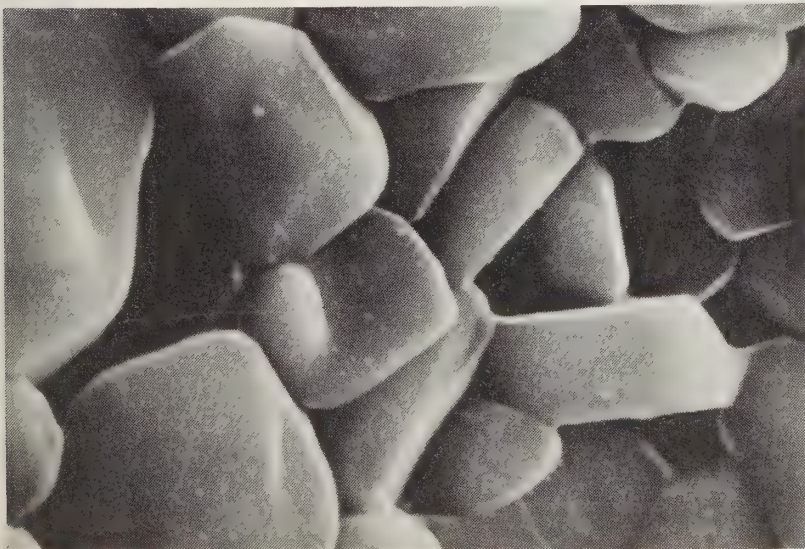
**Contact: Dr. S.P. Bellier
Telephone: (613) 226-1885**



Scanning electron micrograph of intermetallics at gold wire 0.0012 diameter bond of a transistor rejected for use on the NASA space shuttle.



Defective diode after removal of glass seals, Silicon die approximately 1.2 mm per side.



Particles in an alumina substrate used in thick film circuitry. Each particle is about 4 micrometers long.

RAYTHEON CANADA LIMITED

**400 Phillip Street, P.O. Box 1619
Waterloo, Ontario
N2J 4K6**

Satellite Communications Earth Stations

Raytheon Canada, founded in 1956, is a well established supplier of high technology electronic products, systems and associated services for both Canadian and international markets. Prime activities of the company are in telecommunications systems, including satellite earth stations, and air traffic control.

Main Space Communications Systems, Proprietary Products and Services:

- 14/12 GHz earth stations
- 6/4 GHz earth stations
- Up and down converters
- Video terminal equipment
- Telephony terminal equipment
- Digital (90 Mb/s) terminal equipment
- Engineering studies
- Installation and commissioning services
- Operation and maintenance services

Other Company Products and Services:

- Airport surveillance radars
- Doppler VHF omnirange equipment
- Distant measuring equipment
- Terrestrial radio relay equipment

Personnel: 290

Annual sales: \$15 million in 1980

Contact:

Mr. J.E.H. Elvidge

Assistant General Manager

Telephone: (519) 885-0110

Telex: 069-55431

TWX: 610-365-3469



Raytheon Canada 14/12 GHz earth station used by Telesat Canada to receive Anik C satellite signals.



The Raytheon Canada ASR-8000 series radar comprises a number of advanced L and S band primary radars capable of detecting aircraft in extreme weather and clutter conditions.

SATEL CONSULTANTS LIMITED

**1013 Wiseman Crescent
Ottawa, Ontario
K1V 8J3**

Earth Stations Telecommunications System & Engineering

Since 1975, saTel has provided systems engineering, manufacturing and turn-key installation for a broad variety of telecommunications, with emphasis on earth stations for radio, TV etc.

Main Space Communications Systems, Proprietary Products and Services:

- TV, radio, etc. earth stations
- Satellite cue/control switchers
- Transportable TV radio earth stations
- RF Interference compatibility analysis and measurement
- Feasibility/definition studies

Other Company Products and Services:

- Wind/alternate energy systems
- Low power broadcast systems
- CRTC, DOC licence applications
- Ground-air navigation/communications systems
- Meteorological data collection and analysis
- MF, VHF communications systems

Personnel: 7

Annual sales: \$0.85 million in 1980

Contact:

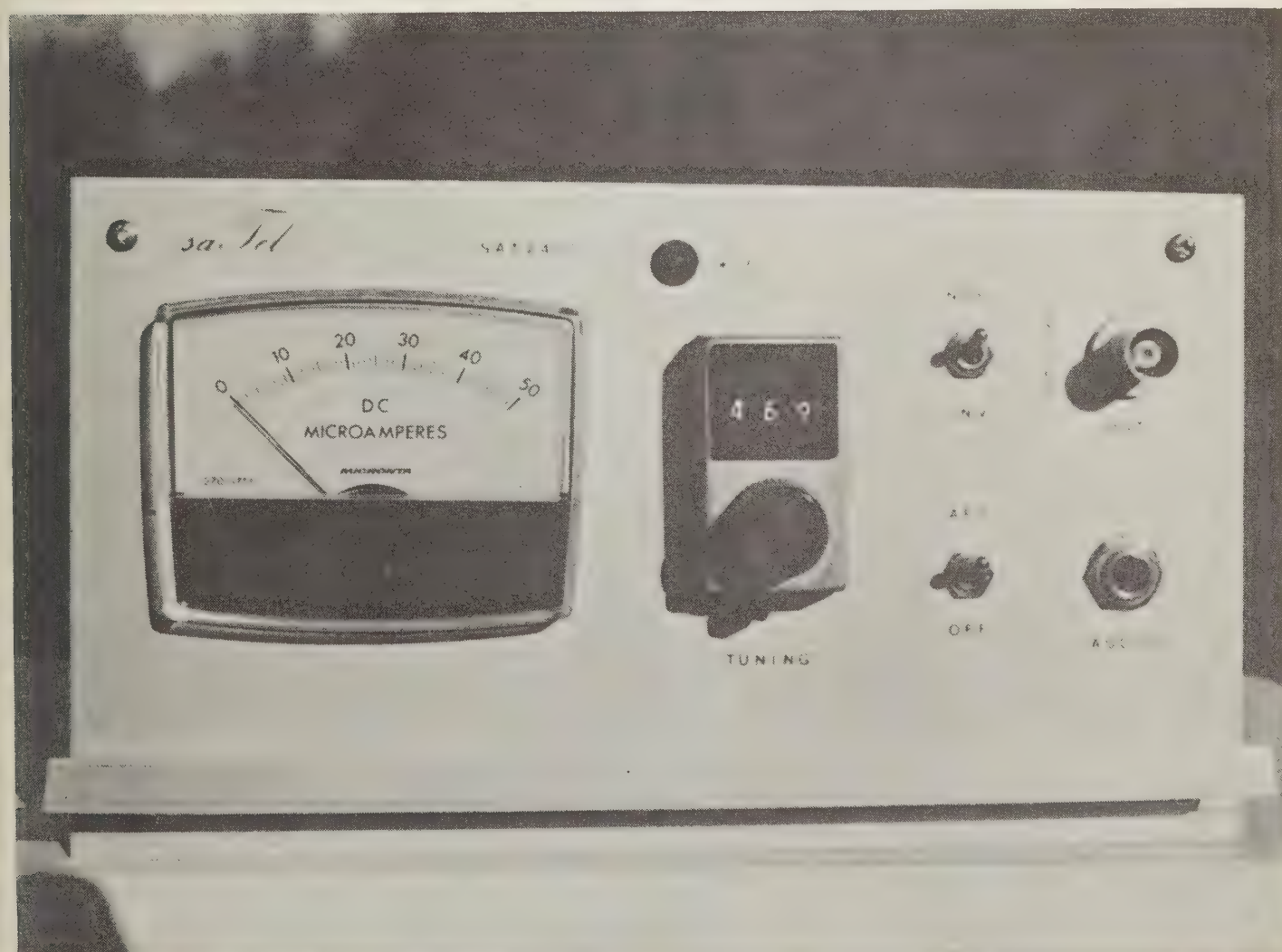
Mr. B.F. Murphy, P. Eng.

Telephone: (613) 733-1878

Telex: 053-4463



saTel TV and radio antenna/low noise amplifier earth station compatible with all 24 satellite channels now in use in Canada.



saTel SAT-24D satellite receiver using advanced integrated circuit techniques.

SED SYSTEMS INC.

P.O. Box 1464

Saskatoon, Saskatchewan

S7K 3P7

Ground Terminals, Earth Stations, Test Facilities

The company was incorporated in 1972 and specializes in the development and fabrication of ground terminals and satellite components.

Main Space Communications Systems, Proprietary Products and Services:

- Terminals for voice, data, radio telephony and television transmission and reception via satellite
- Microwave components
- Transportable earth stations
- Mobile test facilities
- Design and manufacture of 12 GHz direct broadcast terminals

Other Company Products and Services:

- Remote sensing
- Shuttle and rocket payloads
- Satellite ground control facilities
- Satellite systems test equipment
- Landsat station operations
- Satellite data receiving and processing systems
- Low cost telephony terminal satellite systems
- Research and development studies
- Simulators and trainers

Personnel: 260

Annual sales: \$13 million in 1980

Contact:

Mr. M.P. Hodson

President

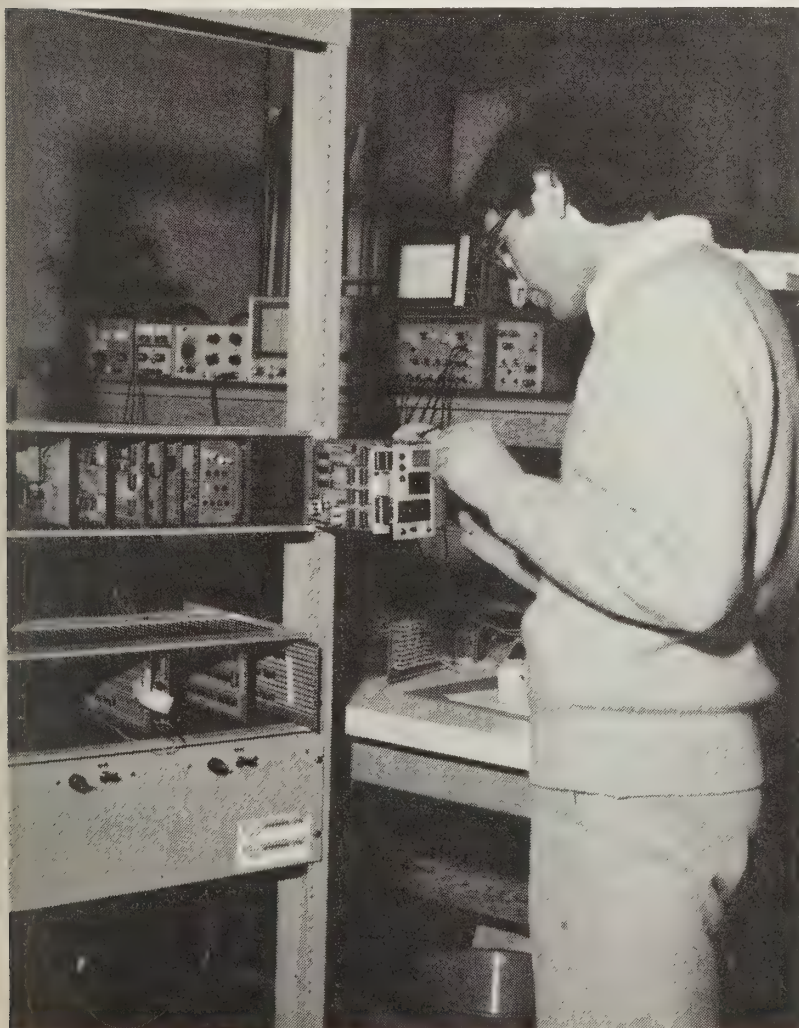
Telephone: (306) 664-1709

Telex: 074-2325

TWX: 610-731-1476



SED small diameter satellite communications direct broadcast 12 GHz terminal.



SED telecommunications electronics workstation at Saskatoon head office

SPAR AEROSPACE LIMITED SPACE & ELECTRONICS GROUP

**1700 Ormont Drive
Weston, Ontario
M9L 2W7**

Satellite Communications Systems

An independent Canadian company founded in 1967 which has participated in every Canadian-made, and many foreign spacecraft. Prime contractor for Telesat Canada's Anik D satellite and NASA's Shuttle Remote Manipulator System.

Main Space Communications Systems, Proprietary Products and Services:

- Complete satellite communications systems
- Satellite subsystems including: solar arrays, transponders, antennas, structures, electronics, earth stations, microwave relay systems
- Remote Manipulator Systems

Other Company Products and Services:

- Remote sensing surveillance systems
- Gears and transmissions
- Aircraft repair and overhaul

Personnel: 1,950

Annual sales: \$128 million in 1980

Contact:

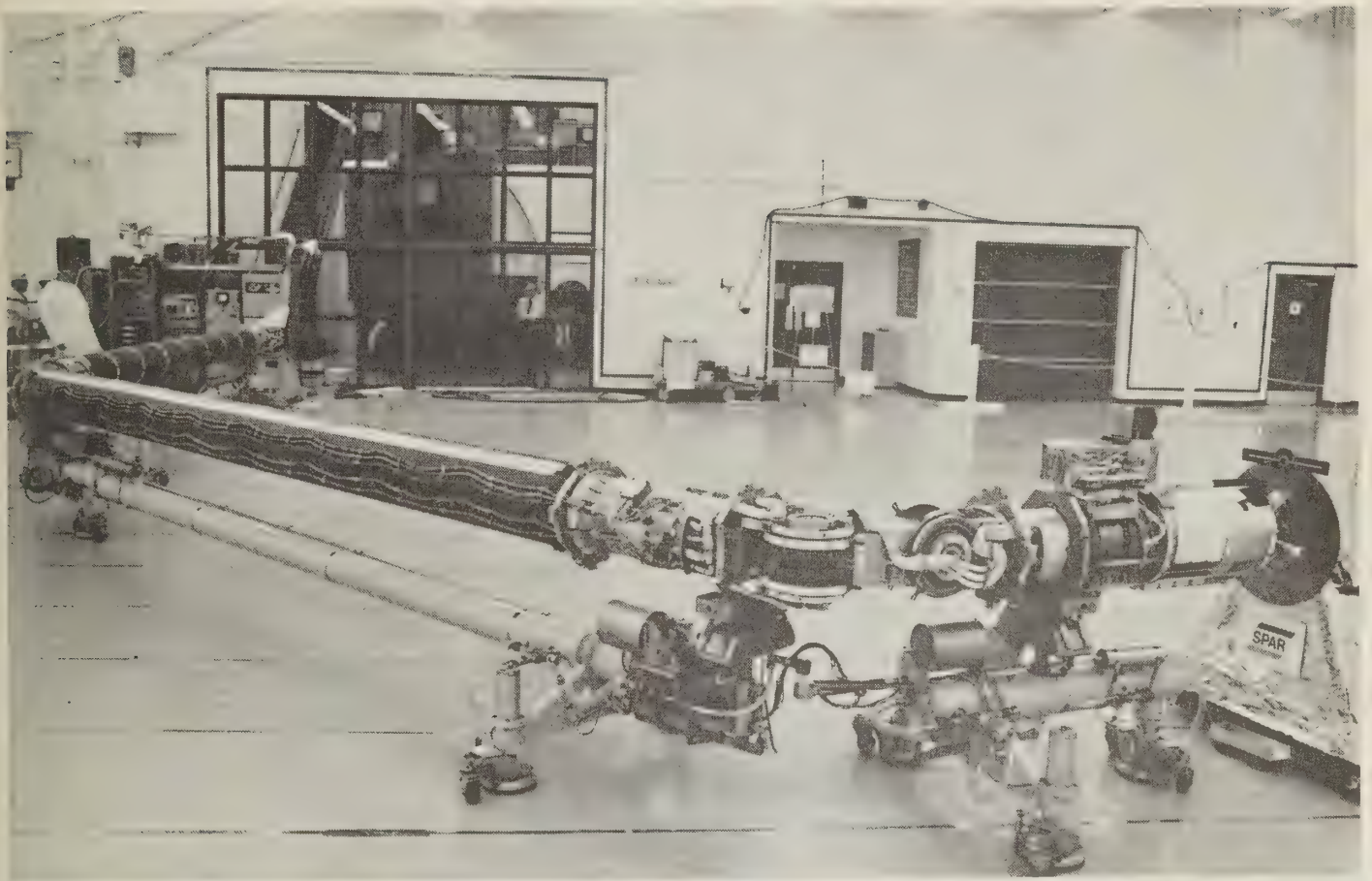
Mr. C.M. Hinds

Director, Marketing

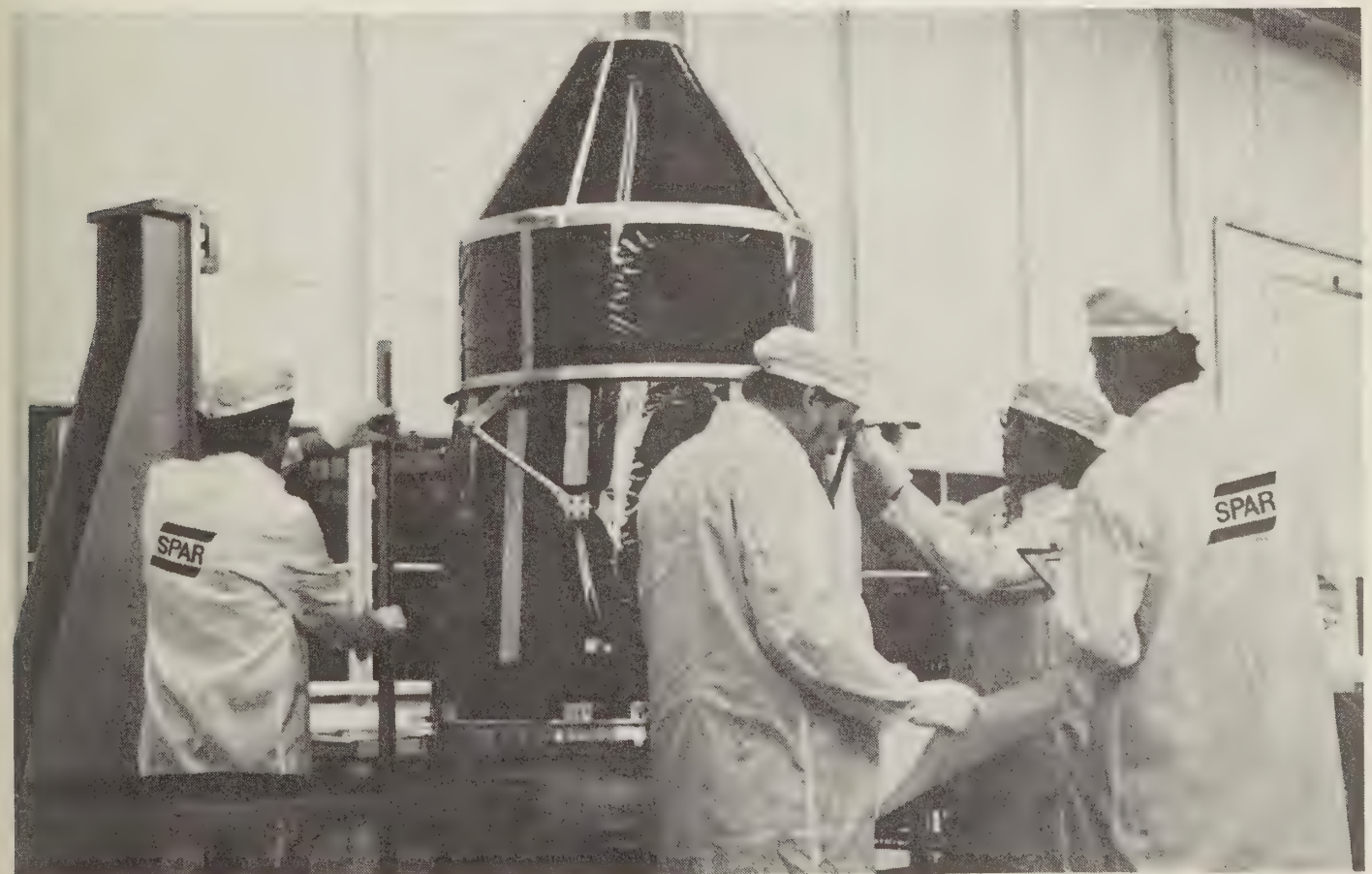
Telephone: (416) 745-9680

Telex: 065-27360

TWX: 610-491-1503



Remote Manipulator System for use on board NASA "Columbia" orbiter, under test at Spar Aerospace, Toronto.



Inspection of Anik C satellite structures at Spar Aerospace, Toronto.

TELEVISION BY SATELLITE INCORPORATED

16 Taber Road
Rexdale, Ontario
M9W 3A5

Microwave Antennas

The company was incorporated in 1980 and has developed a line of low cost fiberglass microwave antennas in 3.7 to 4.2 GHz and 12 GHz bands.

Main Space Communications Systems, Proprietary Products and Services:

- High efficiency receive only antenna system in 4 GHz and 12 GHz bands
- Total protection of radio wave reflective surface
- Remotely operated antenna tracking system
- TV/FM receiver-modulators 4 GHz band

Personnel: 6

Annual sales: \$200,000 in 1981

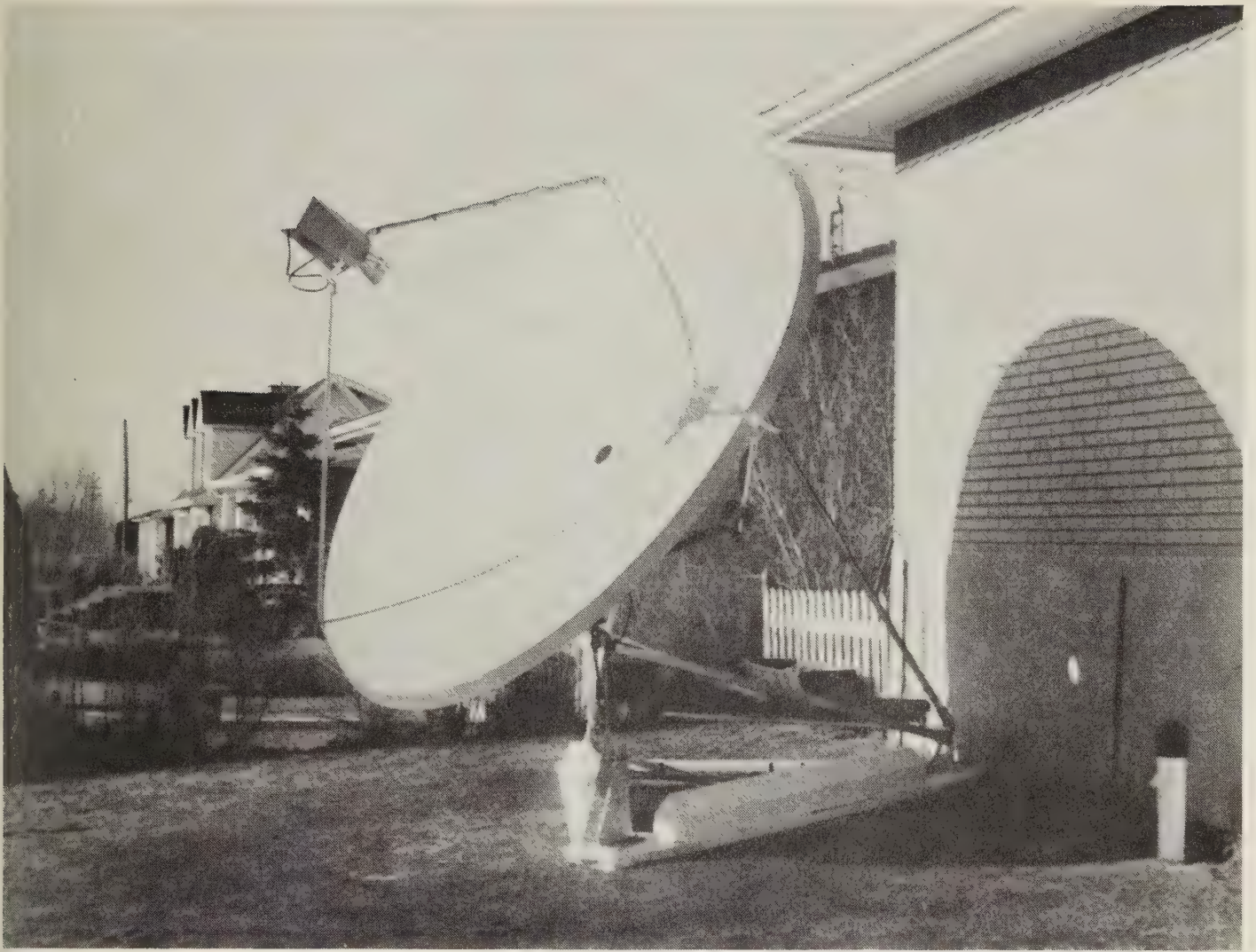
Contact:

Mr. Jan Spisar ✓

President

Telephone: (416) 745-3040

Connect to Triple Crown



Home user 3.2 m antenna system manufactured by TSI.

TIW SYSTEMS LTD.

**629 Eastern Avenue
Toronto, Ontario
M4M 1E4**

Satellite Tracking Systems

Incorporated in 1973, the firm is engaged in design, marketing and construction of satellite tracking antennas.

Main Space Communications Systems, Propriety Products and Services:

- Satellite tracking antennas
- Antenna support structures
- Surface panels
- Servo drives
- Microprocessors

Other Company Products and Services:

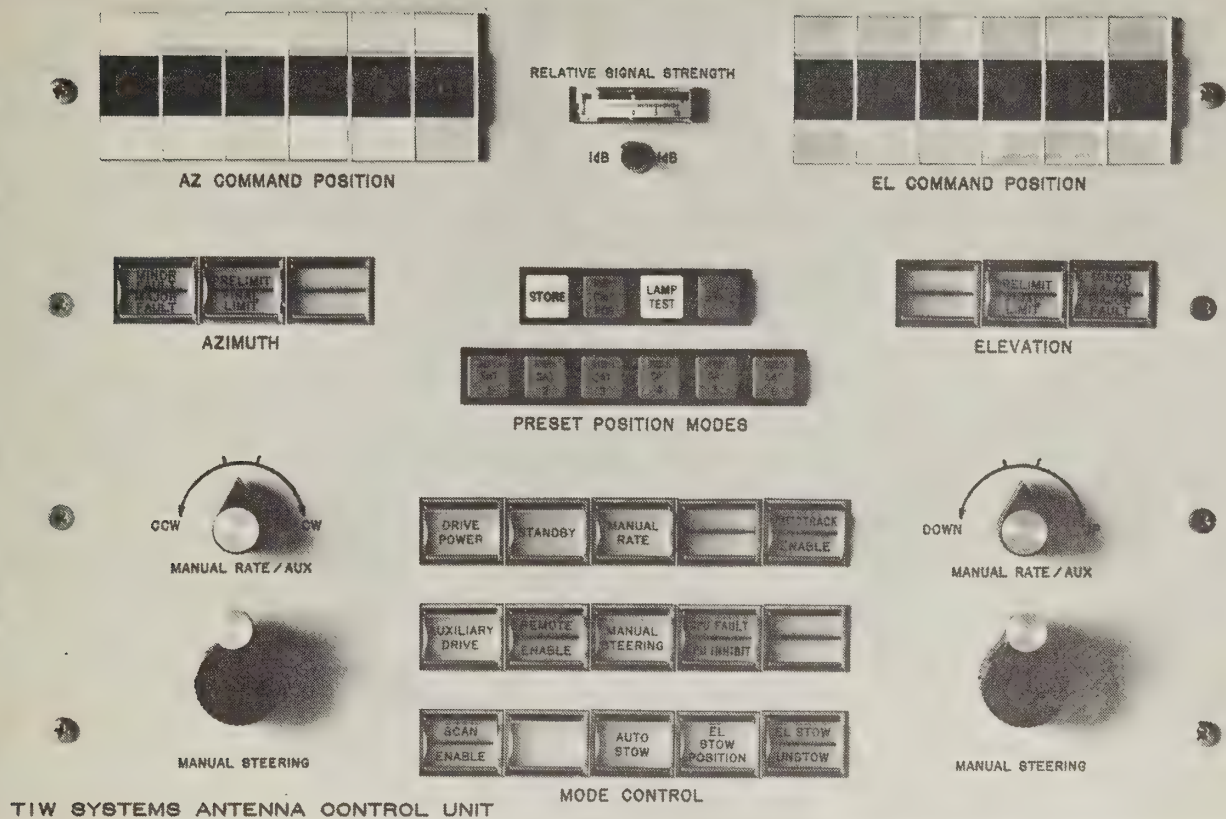
- Design, marketing and electrical component manufacturing facilities also located in Sunnyvale, Calif.

Personnel: 75

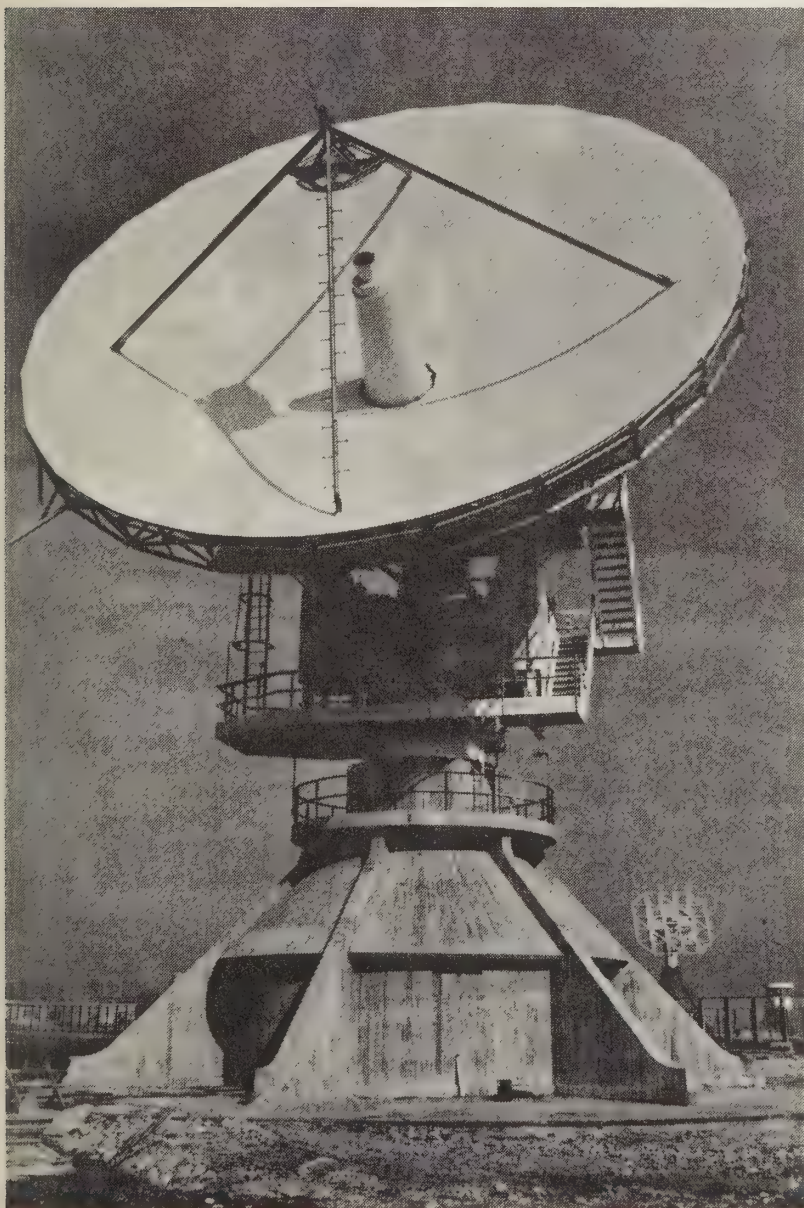
Annual Sales: \$8 million in 1980

contact:

**Mr. Donald M. Cameron
Telephone: (416) 416-8111
Telex: 06-2208 (Toronto)**



TIW Systems automatic control unit for satellite tracking systems.



TIW Systems 16.5 TTC & M satellite tracking antenna.

TRIPLE CROWN ELECTRONICS INC.

**42 Racine Road
Rexdale, Ontario
M9W 2Z3**

TVRO Satellite Receiver

The firm was founded in 1972 as a CATV (Cable TV) supplier and now markets products ranging from amplifiers to processors to test equipment to TVRO receivers.

Main Space Communications Systems, Proprietary Products and Services:

- TVRO satellite receivers

Other Company Products and Services:

- Amplifiers, broadband
- RF signal processors
- RF test equipment
- Satellite stereo signal processors

Personnel: 80

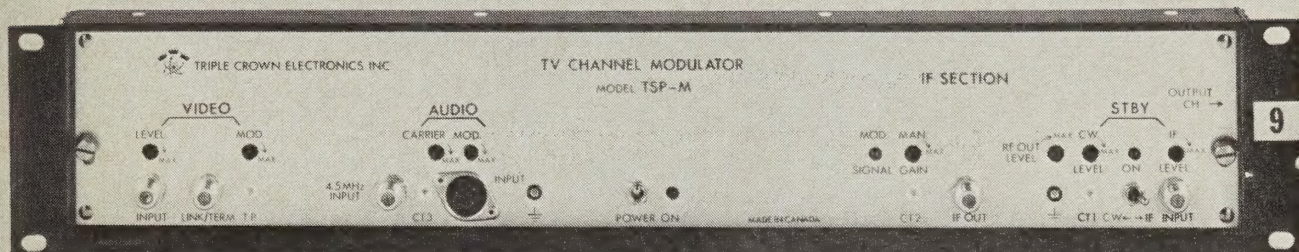
Annual sales: \$3 million in 1980

Contact:

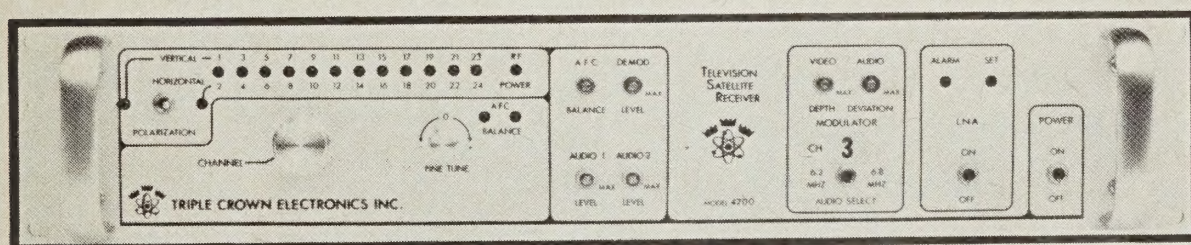
Mr. David Emberson

Telephone: (413) 743-1481

Telex: 06-989292



Triple Crown TV channel modulator model TSP-M which converts IF signal to any TV channel (5 - 900 MHz) using up-converter section for TVRO application.



Triple Crown television satellite receiver 4000 series for TVRO application which produces 70 MHz IF signal by dual conversion and accepts 3.7 to 4.2 MHz band.

SPACE INDUSTRY CONSULTANTS/SERVICES

- | | |
|--|--|
| <p>Applied Telecommunications Ltd.
 976 Kingsmere Avenue
 Ottawa, Ontario
 K2A 3K4</p> | <p>Consultant services
 Contact:
 Dr. I. Paghis
 Telephone: (613) 729-7933</p> |
| <p>Bell-Northern Research Ltd.
 P.O. Box 35511, Station 'C'
 Ottawa, Ontario
 K1Y 4H7</p> | <p>Telecommunications research
 and development
 Contact:
 Mr. Ray F. Fortune
 Telephone: (613) 596-2304
 Telex: 053-3175
 TWX: 610-562-1914</p> |
| <p>Cantel Engineering Associates Ltd.
 1221 West 23rd Street
 North Vancouver, B.C.
 V7P 2H5</p> | <p>Satellite consulting engineering services
 Contact:
 Mr. A.C. Gardiner, P.Eng.
 Telephone: (604) 980-4911
 Telex: 04-507775</p> |
| <p>DSMA ATCON Ltd.
 4195 Dundas Street West
 Toronto, Ontario
 M8X 1Y4</p> | <p>System engineering and design
 services
 Contact:
 Mr. I.J. Billington
 Telephone: (416) 239-3011
 Telex: 06-967880</p> |
| <p>Geostudio Consultants Ltd.
 525 St. Laurent Blvd. Suite 24
 Ottawa, Ontario
 K1K 2Z9</p> | <p>Satellite imagery interpretation
 services
 Contact:
 Dr. R. Steffensen
 Telephone: (613) 746-2950</p> |
| <p>Intera Environmental
 Consultants Ltd.
 204-2841 Riverside Drive
 Ottawa, Ontario
 KIV 8N4
 ...also....
 406-7015 McLeod Trail
 Calgary, Alberta
 T2H 1X9</p> | <p>Remote sensing, meteorological and
 numerical modelling services
 Contact:
 Mr. Kirby (Ottawa)
 Mr. M. Wride (Calgary)
 Telephone:
 (613) 523-5530 (Ottawa)
 (403) 253-8895 (Calgary)
 Telex:
 05-34307 (Ottawa)
 03-824537 (Calgary)</p> |

Philip A. Lapp Ltd.
280 Albert Street, Suite 904
Ottawa, Ontario
K1P 5G8

Systems management and policy consultants on space, telecommunications and other applications

Contact:

Dr. Philip A. Lapp

Telephone: (416) 920-1994

Louis Technology Services Ltd.
1843 Kilborn Avenue
Ottawa, Ontario
K1H 6N3

Satellite earth station engineering, technology search and transfer, feasibility studies and marketing

Contact:

Mr. H. Louis, P.Eng

Telephone: (613) 731-7465

Reltek Inc.
302 Leggett Drive
Kanata, Ontario
K2K 1Y5

Space component reliability analysis and screening; Burn-in of components; AC/DC electrical testing; temperature stabilization; PIN-D testing, component radiography; temperature cycling; screening to Mil. Std. 883

Contact:

Mr. Larry O'Brien

Telephone: (613) 592-2411

Remotec Application Inc.
P.O. Box 5547
St. John's Nfld.
A1C 5W4

Remote sensing services and research and development

Contact:

Mr. Richard D. Worsfold

Telephone: (709) 364-1779

Telex: 016-4939

Telesat Canada
333 River Road
Ottawa, Ontario
K1L 8B9

Satellite telecommunications carrier

Contact:

Mr. John Almond

Telephone: (613) 746-9852

Telex: 053-3204

TWX: 610-562-1963



Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

Canada